COMPARING THE DIAGNOSTIC ACCURACY OF DETECTING DYSMORPHIC RBCs IN AUTOMATED URINE ANALYSERS SYSMEX UX - 2000 AND IRIS iQ - 200 WITH MANUAL PHASE CONTRAST MICROSCOPY IN CASES OF MICROSCOPIC HEMATURIA.

A DISSERTATION SUBMITTED IN PART FULFILMENT OF THE REGULATION FOR THE AWARD OF THE DEGREE OF M.D. PATHOLOGY BRANCH III.

THE TAMIL NADU DR. M.G.R. UNIVERSITY,

CHENNAI, TAMIL NADU

MAY-2018

Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analysers Sysmex UX - 2000 and IRIS iQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria.

A dissertation submitted in part fulfilment of the regulation for the award of the degree of M.D. Pathology Branch III.

CERTIFICATE

This is to certify that this dissertation "Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analysers Sysmex UX - 2000 and IRIS iQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria" is the bonafide work done by Dr. Anju Mohan, in part fulfilment of the rules and regulations for the M.D. Branch III (Pathology) Degree Examination of Tamilnadu Dr. M.G.R. Medical University, to be held in May 2018.

Dr.Vivi M Srivastava, MBBS, MD.

Professor and Head,

Department of Pathology,

Christian Medical College,

Vellore.

PROFESSOR AND HEAD,
DEPARTMENT OF PATHOLOGY,
Christian Medical College,
IDA Scudder Road, Vellore - 632 004. INDIA.

Dr. Anna B Pulimood, MBBS, MD, PhD

Principal,

Christian Medical College,

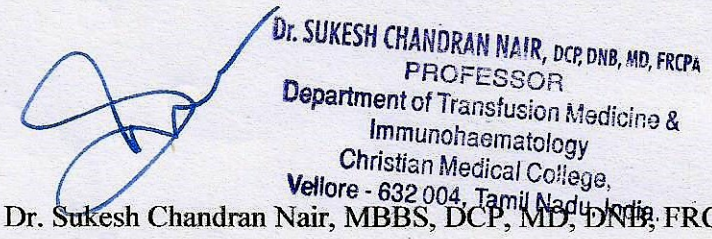
Vellore.

PRINCIPAL
Christian Medical College
Vellore - 632 002, Tamil Nadu, India.

CERTIFICATE

This is to certify that this dissertation "Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analysers Sysmex UX - 2000 and IRIS iQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria" is the bonafide work done by Dr. Anju Mohan, in part fulfilment of the rules and regulations for the M.D. Branch III (Pathology) Degree Examination of Tamilnadu Dr. M.G.R. Medical University, to be held in May 2018.

The candidate has independently reviewed the literature, standardized the data collection methodology and carried out the evaluation towards completion of the thesis.



Dr. Sukesh Chandran Nair, MBBS, DCP, MD, DNB, FRCPA (HAEM).

Professor,

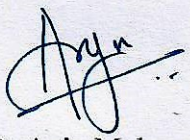
Department of Transfusion Medicine and Immunohematology,

Christian Medical College, Vellore.

CERTIFICATE

This is to certify that this dissertation "Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analysers Sysmex UX - 2000 and IRIS iQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria" is a bonafide work done by me, under the guidance of Dr. Sukesh Chandran Nair, in part fulfilment of the requirements for the M.D Branch III (Pathology) Degree Examination of the Tamil Nadu Dr. M.G.R Medical University, to be held in May 2018.

I have independently reviewed the literature, performed the data collection, analyzed the methodology and carried out the evaluation towards completion of the thesis.



Dr.Anju Mohan,

PG Registrar,

Department of General Pathology,

Christian Medical College,

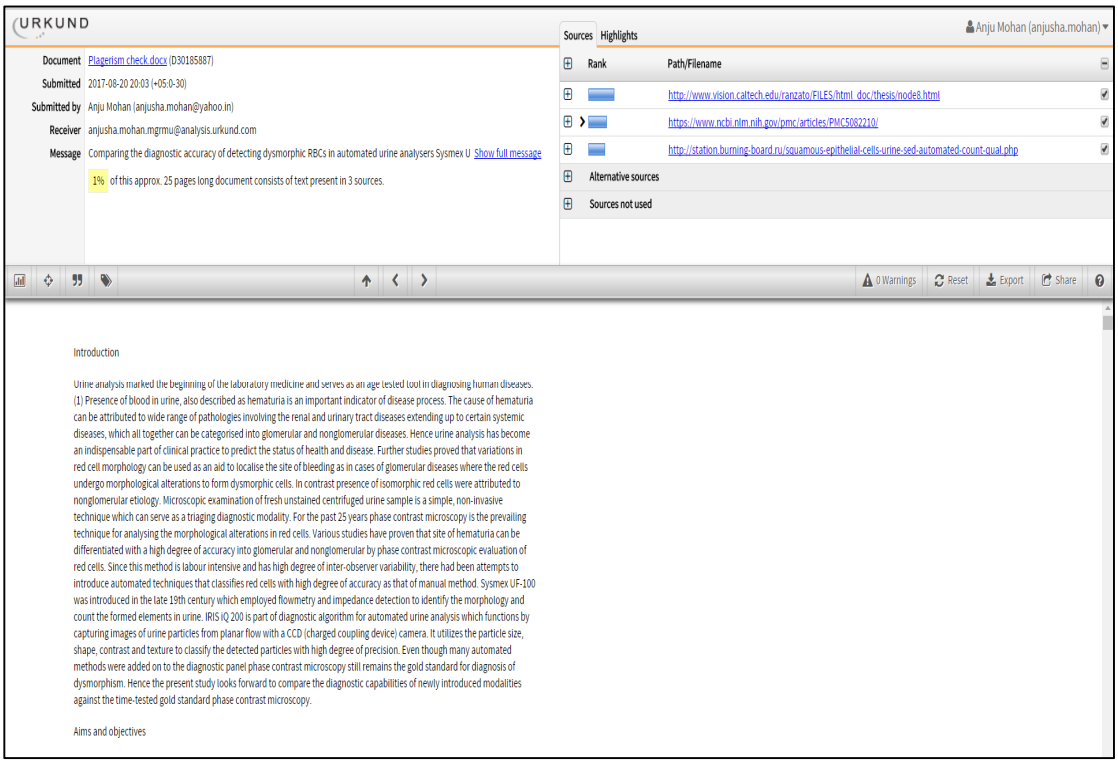
Vellore.

DR. MGR UNIVERSITY PLAGIARISM SOFTWARE ANALYSIS REPORT:

URKUND

Document	Plagerism check.docx (D30185887)
Submitted	2017-08-20 20:03 (+05:0-30)
Submitted by	Anju Mohan (anjusha.mohan@yahoo.in)
Receiver	anjusha.mohan.mgrmu@analysis.urkund.com
Message	Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analysers Sysmex U Show full message

1% of this approx. 25 pages long document consists of text present in 3 sources.



CERTIFICATE – II

This is to certify that this dissertation work titled "Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analysers Sysmex UX - 2000 and IRIS IQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria" of the candidate Anju Mohan with registration Number 201513352 for the award of Degree of MD Pathology in the Branch III. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows 1 percentage (1%) of plagiarism in the dissertation.

Guide & Supervisor sign with Seal.

Dr. SUKESH CHANDRAN NAIR, DCP, DNB, MD, FRCPA
PROFESSOR
Department of Transfusion Medicine &
Immunohaematology
Christian Medical College,
Vellore - 632 004, Tamil Nadu, India.

ACKNOWLEDGEMENT

I express my heartfelt gratitude to my guide Dr. Sukesh Chandran Nair (Professor, Department of Transfusion Medicine and Immunohematology) for his excellent guidance, careful scrutiny and constant inspiration given to me during this study and throughout my course. I am highly indebted to Dr. Joy J Mammen (Professor and Head of the Department of Transfusion Medicine and Immunohematology) for his informative guidance all throughout this study.

I am deeply obliged to Dr Vivi Srivastava (Professor and Head of the Department of General Pathology) for her encouragement and support given to me throughout my course.

I would like to express my sincere gratitude to Dr. Santhosh Varughese, Professor of Nephrology, Dr. Anna T Valson, Associate Professor, Department of Nephrology and Dr. Anthony Devassia, Department of Urology for the necessary guidance from a clinicians' perspective during the study. I would extend my sincere thanks to Mrs. Tunny Sebastian and Miss Kavitha, biostatisticians for the statistical support provided.

I would like to thank all patients who were part of this study, who were indispensable for the completion of this dissertation.

I am highly indebted to my parents and my husband who were the constant source of support and inspiration towards the successful accomplishment of this endeavour of mine.

Above all, I would like to thank the Lord Almighty, whose grace and blessings enabled me to learn and improve myself while completing this endeavour.

ABBREVIATIONS

dRBC: dysmorphic Red blood cells

RBC: Red blood cells

PCM: Phase contrast microscopy

FCM: Flow cytometry

CHM: Chemical analysis

IRIS: International remote imaging system

LIS: Laboratory Information System

CCD: Charge coupling device

ULC: Unclassified

CONTENTS

LIST OF FIGURES:

LIST OF TABLES:

INTRODUCTION

Urine analysis marked the beginning of the laboratory medicine and serves as an age tested tool in diagnosing human diseases.(1) Presence of blood in urine, also termed as hematuria is an important indicator of disease process. The cause of hematuria can be attributed to a wide range of pathological conditions involving the renal and urinary tract diseases, extending up to certain systemic diseases, which all together can be categorised into glomerular and nonglomerular diseases. Hence urine analysis has become an indispensable part of clinical practice to predict the status of health and disease. Further studies proved that variations in red cell morphology can be used as an aid to localise the site of bleeding as in cases of glomerular diseases where the red cells undergo morphological alterations to form dysmorphic cells. In contrast presence of isomorphic red cells were attributed to nonglomerular etiology. Microscopic examination of fresh unstained centrifuged urine sample is a simple, non-invasive technique which can serve as a triaging diagnostic modality. For the past 25 years phase contrast microscopy is the prevailing technique for analysing the morphological alterations in red cells. Various studies have proven that site of hematuria can be differentiated with a high degree of accuracy into glomerular and nonglomerular by phase contrast microscopic evaluation of red cells. Since this method is labour intensive and has high degree of inter-observer variability, there had been attempts to introduce automated techniques that classifies red cells with high degree of accuracy as that of manual method. Yellow IRIS analysis was the first to be added on to the diagnostic algorithm of automation in urinalysis. (2) It functions by capturing images of urine particles from planar

flow with a CCD (charged coupling device) camera. It utilizes the particle size, shape, contrast and texture to classify the detected particles with high degree of precision. Many studies have approved the increased precision of this analyser above the conventional methods in detecting dysmorphic red cells.(3) Sysmex UF-100 was introduced in 1990s which employed flowmetry and impedance detection to identify the morphology and count the formed elements in urine.(4) Even though many automated methods were added on to the diagnostic panel, phase contrast microscopy still remains the gold standard for diagnosis of dysmorphism. Hence the present study looks forward to compare the diagnostic capabilities of newly introduced modalities against the time-tested gold standard phase contrast microscopy in detecting glomerular hematuria.

AIMS & OBJECTIVES

2.1. To compare the diagnostic accuracy of dysmorphic RBC analyser Sysmex UX - 2000 with phase contrast microscopy in detecting dysmorphic red cells in cases of microscopic hematuria.

2.2. To compare the diagnostic accuracy of dysmorphic RBC analyser IRIS iQ 200 with phase contrast microscopy in detecting dysmorphic red cells in cases of microscopic hematuria.

2.3. To compare the diagnostic capabilities of automated analysers Sysmex UX - 2000 and IRIS iQ 200 in detecting dysmorphic red cell population.

REVIEW OF LITERATURE

Urine analysis is one of the routinely requested tests in clinical practice for effective diagnosis as well as screening of many diseases. Unlike the other tests available in laboratory medicine, urine analysis provides the advantage of diagnosis as well as assessment of clinical disease progression with least patient distress.(5) European Urinalysis Guidelines provides a two-step analysis protocol for urine examination, the first being visual analysis and dipstick evaluation which is followed by the microscopic sediment analysis of urine.(6) Among all the manifestations of deranged renal function, hematuria is of utmost importance in not only being an alarming signal to the patient warranting clinical attention but also being an aid to narrow down the diagnostic algorithm to the pathology behind. In the samples with proven hematuria on dipstick analysis, further categorisation for clinical differentiation is based on the microscopic analysis. Microscopic evaluation with the aid of phase contrast microscope is an age tested diagnostic modality to assess the morphological variations in urinary red blood cells. Being a labor-intensive method with high degree of inter-observer variations in microscopic urine analysis various attempts have been made for automation in this field. With the discovery that the glomerular bleeding gives rise to morphological alterations in urinary red blood cells, much of the research had been channelled to furnish the existing diagnostic modalities for the identification of the same and to bring about newer diagnostic aids.

3.1. History:

Laboratory medicine started with analysis of human urine nearly 6000 years ago. It was initially called as uroscopy which originated from the word ‘uroscopia’ meaning ‘scientific examination of urine’. The Babylonian and Egyptian physicians were the pioneers in the field of uroscopy. Till the end of Victorian era uroscopy was considered as the primary diagnostic tool. (7) It was Hippocrates who stated that pus and blood in urine can be attributed to ulceration of kidney or bladder. The presence of blood in urine was documented in the ancient literatures where the first century physician Rufus, of Ephesus had hypothesized that the patients urinated blood due to the widening of the channel which led the blood and other thick substances into the urine. Many cases of hematuria that he observed in the tropics was attributed to the parasitic infestation of bladder by schistosomiasis. (8),(9) With the advent of lenses to observe the urine microscopically, the 17^{th} century marked the beginning of ‘urinalyses’ which embodied the microscopic evaluation of formed elements in urine. Sir William Bowman who excelled in the renal histological studies, was the first to propose that erythrocytes can pass through the Malpighian corpuscles in many diseased conditions, though he did not attempt to examine urine under microscopy.(10) It was the French nephrologist, Pierre Rayer in 1837 who introduced urine microscopy to clinical practice. He noted that “otherwise normal (clear) urine might nevertheless contain an excess of red cells” which was the first description for microscopic hematuria.(11) Initial attempts were made by Addis (12) who noted the fragmented and partially lysed cells while

Carter (13) stained those cells for better definition of morphology. But they failed to find a clinical significance for the morphological alterations in urinary red cells. In 1841 Alfred Becquerel, the French physicist and researcher, described red blood cells in urine as “plus souvent d eform es et irreguliers” in his classic treatise on the analysis of urine — which is probably the first description of irregular-dysmorphic red blood cells. Sir. Golding bird did diagrammatic description of erythrocytes as round cell with rouleaux formation of which some red blood cell showed evidence of membrane spikes. He also described the abnormal red cells with spikes and hooks. (10) Further the diagnostic armamentarium for urine analysis reached new heights with the introduction of phase contrast microscopy, pioneered by Frits Zernikein the 1930s.

3.2. Definition of hematuria:

Passage of blood in urine also known as hematuria addresses an important diagnostic dilemma in the clinical practice. A normal individual excretes approximately 0.5-2 million red cells in a 24 hour urine sample which amounts to <5 red blood cells/hpf on microscopic examination in a spun urine sample.(14) American Urologic Association (AUA) guidelines panel defines microscopic hematuria as the presence of more than 5 red blood cells per high power field (5/hpf) in a mid-stream caught urine sample. AUA also states that a single positive urinalysis should prompt further evaluation.(15), (16) A large amount of blood obvious to naked eye is defined gross or macroscopic hematuria, where in the red blood cell count in urine is always well above 10^6 cells per ml.(17) Hematuria can be further categorised based on its visibility and timing in the

urinary system. The term gross hematuria is defined as frank or visible or macroscopic hematuria that can be seen with naked eye. Gross hematuria can be further characterised into initial, terminal and total based on the phase of urinary stream during which blood is visible in urine. Initial hematuria indicates the blood in urine originating from the urethral source. Terminal hematuria accounts for bleeding from bladder trigone, neck of bladder and prostate while total hematuria can occur anywhere from bladder and above. Hematuria whether macroscopic and microscopic, is an important indicator of significant renal, urological and systemic disease.

The morphological analysis and quantitation of the urinary red cells are the two most important investigations used in clinical nephrology and urology. In addition to providing information regarding the underlying disease condition, this morphometric analysis aids in deciding the further investigation protocol. Hence over the years, prompt assessment of the number and morphology of urinary erythrocytes has gained a lot of significance.(17)

3.3. Prevalence of hematuria:

The American Urological Association estimates the prevalence of 2.4% to 31.1% for microscopic hematuria in a population based screening analysis done over 80,000 individuals, with higher rates in males over age 60 years and with a significant history of smoking in the past and present. Microscopic hematuria is reported with a prevalence of 0.2 to 16.1% based on the analysis done in population based and referral based analysis. (18, 19)

The Kidney Early Evaluation Program (KEEP) emphasizes the importance of urinalysis in routine clinical practice and suggests that hematuria and proteinuria can act as valuable indicators in early diagnosis of an evolving pathology. (20)

3.4. Causes of hematuria:

The presence of blood in the urine irrespective of being microscopic or macroscopic was attributed to wide range of illness including urinary tract infection, nephrolithiasis, cystolithiasis, sickle cell anaemia, bladder cancer, cystic kidney disease, and ranging up to glomerulonephritis. Causes of hematuria can even be extrapolated to various physiological conditions including exercise. (21) Hematuria can arise from anywhere along the urinary tract extending from glomeruli to the urethra. Hence causes of hematuria can be broadly classified into nephrological and urological conditions which comes under the arms of glomerular and nonglomerular diseases respectively. (22) Early detection of hematuria and categorisation into respective arms of diagnosis is of utmost importance in treatment. (23) As Campell’s textbook of Urology states: "Hematuria may be gross or microscopic, but it must be emphasized that the degree of hematuria bears no relationship to the possible cause. Any red blood cells seen in a centrifuged specimen of urine must be considered significant. Hematuria should never be ignored, and no matter how trivial the bleeding may seem, a complete urological investigation into its cause is mandatory." (15)

Lower urinary tract bleeding	Upper urinary tract (renal) bleeding
Tumors (urethra, bladder, prostate, ureters, renal pelvis)	**Primary glomerulopathies**
Obstructive uropathy	Immunoglobulin A nephropathy
Benign prostatic hyperplasia	Postinfectious glomerulonephritis
Lithiasis (stones)	Membranoproliferative glomerulonephritis
Infections (cystitis, prostatitis, schistosomiasis, tuberculosis, condyloma acuminatum)	Focal glomerular sclerosis
Coagulopathy	**Secondary glomerulopathy**
Trauma	Lupus nephritis
Radiation therapy	Henloch-Schönlein syndrome
Instrumentation	Vasculitis (polyarteritis nodosa)
Vigorous exercise	Wegener granulomatosis
Menstrual contamination	Hemolytic-uremic syndrome
Endometriosis	Essential mixed cryoglobulinemia
	Interstitial nephritis
	Familial conditions
	Hereditary nephritis (Alport syndrome)
	Hemoglobinopathies
	Metabolic disorders (hypercalcuria)
	Polycystic kidney
	Infections
	Pyelonephritis (acute or chronic)
	Tuberculosis
	Cytomegalovirus
	BK polyomavirus
	Nephrolithiasis
	Light chain deposition
	Diabetic nephropathy
	Amyloid
	Renal tumors (renal cell carcinoma)

Table 1: Causes of Hematuria [21]

Most common causes for gross hematuria is attributed to urinary tract infection followed by malignancy and urolithiasis in adults while in paediatric population the idiopathic reasons, hypercalciuria, congenital anomalies, urolithiasis, urinary tract infections and malignancies top the list. In adults, the

most common causes for microscopic hematuria are idiopathic causes followed by malignancy, urolithiasis, urinary tract infection and renal disease in the order of reducing frequency. On evaluation of paediatric population for microscopic hematuria, the idiopathic source was first in list followed by hypercalciuria, renal disease, urolithiasis and congenital abnormalities. (24)

3.5. Dysmorphic red blood cell:

Urine analysis gained importance when it was noted that glomerular bleeding gives rise to wide range of morphological alterations in the red cell membrane. Assessment of the structural details of urinary red cells facilitated the clinical triaging of patients with microscopic hematuria into glomerular and nonglomerular etiology. 'Dysmorphic red blood cells' indicates the morphologically deformed red cells with variation in size and shape along with loss of haemoglobin. These changes were found to be associated with hematuria secondary to glomerular injury. Nonglomerular diseases are associated with red cells with uniform morphology with least haemoglobin loss, which were designated as 'isomorphic red blood cells'. (23), (24)

In 1979 Birch and Fairley first attempted to classify urinary red cells based on their morphology into glomerular and nonglomerular pathology. They put forth the idea of utilising the phase contrast microscopy as a tool with high diagnostic accuracy in detecting the morphological changes of red cells of glomerular pathology and tagged them as dysmorphic red cells. They also described a wide range of structural forms of dysmorphic red cells when compared to nonglomerular isomorphic red cells which predominantly displayed

two forms. There were attempts to correlate the cases of dysmorphic red cells to histopathological diagnosis and they came to the conclusion that there was significant amount of association up to the level that patient can be promptly referred to the nephrologist and urologist for further management based on a single non-invasive diagnostic tool of phase contrast microscopic analysis of urine. (11), (21)

Later in 1982 they illustrated the diverse morphological forms of dysmorphic red cells employing 88 patients of which 58 were having glomerular etiology. The described morphological forms includes the red cells which appeared to have extruded small phase dense blebs of cytoplasm from the cell membrane, those in which the cell membrane appear to have ruptured with loss of cytoplasm, those with granular deposition of phase dense material at intervals around the inner aspect of cell membrane and a “doughnut” cell with peripheral cytoplasmic extrusions. They also observed that the red blood cells in urine seen in association with bleeding into renal pelvis, ureter or urinary bladder had conventional uniform morphology with normal haemoglobin content. Ghost cells and crenated cells were also described among the isomorphic red cells. The study found out that removal of the underlying cause in nonglomerular diseases resulted in the complete resolution of hematuria and complete absence of isomorphic red cells in urine. The presence of isomorphic red cells in IgA nephropathy was explained by Birch and Fairley as the vascular lesions present in the urinary tract can be attributed to the presence of nonglomerular mode of presentation. (22)

In the same year Fasset et al had attempted to predict the source of hematuria in a blind ended study, by analysing the urinary red blood cell morphology. 253 patients with a definite diagnosis were subjected to phase contrast evaluation of urine sample. A diagnosis of glomerular hematuria was made when ≥ 80% of red cells were dysmorphic and nonglomerular hematuria when ≥ 80% red cells were isomorphic. They described mixed hematuria with equal proportion of dysmorphic and isomorphic red blood cells which was more commonly seen in subjects with IgA nephropathy and renal calculi. They obtained a sensitivity and specificity of 99% and 93% in diagnosing glomerular bleeding by phase contrast microscopy. They also hypothesised that the possible explanations for dysmorphism were physical disruption of the red-cell membrane during passage through the glomerular basement membrane or osmotic disruption during passage through the distal tubules. But they ruled out a possibility of osmotic change induced dysmorphism based on the preliminary observations made in the laboratory during the study. (25)

Further in 1983 Birch and Fairley extended the study employing a larger population and also utilised electron microscopic evaluation of urinary erythrocytes. They demonstrated the wide range of morphological alterations in dysmorphic red cell population which are presumed to be occurring due to environmental changes suffered by the red cells as they pass through the renal tubules. (26)

Studies on the morphological changes of red blood cells were continued by Roth et al who demonstrated the various structural forms of glomerular and

nonglomerular erythrocytes.(27) Abdurrahman et al also attempted to find the diagnostic accuracy of phase contrast microscopy in diagnosing hematuria where he found a sensitivity and specificity of 93 and 100% respectively. (28) Mohammed et al in 1993 carried out the same study involving a population of 109 patients and obtained a sensitivity of 90% and specificity of 100% in diagnosing dysmorphic red cells by using phase contrast microscope. (29)

There had been attempts to analyse the red cells in urine by other modalities, one of which was by Chang et al who demonstrated the red cells in dried smears of urine sediments with Wright stain. In the stained smears he observed that the urinary red cells arising due to glomerular pathology were characteristically dysmorphic and hypochromic.(30)

In 1986 Raman et al disputed the reliability in diagnosing glomerular pathology by dysmorphic red cell population. The study involved a total of 109 patients. But he was not able to find a significant correlation between in red cell morphology and glomerular etiology of hematuria. He also suggested that proteinuria associated with the presence of casts in uncentrifuged urine was a better indicator for glomerular etiology than red-cell morphology. (31)

In 1987, De Santo et al studied 168 patients aged 2-75 years with established hematuria to study the correlation between red cell morphology and final diagnosis and also to determine the minimum incidence of dysmorphic red cells to determine the diagnosis of glomerular bleeding. They found out that whenever more than 80% of red cells are dysmorphic, a glomerular origin of bleeding can be made out. (32)

Kohler et al in 1991 described the characteristic morphology for glomerular bleeding as acanthocytes, the red cells with ring like morphology with vesicular membranous protrusions.(33) Tomita et al in 1992 proposed a classification for morphologically categorising the red cells for a differential diagnosis of glomerular hematuria. 5 morphological forms were described under each category and the correlation with the final diagnosis was ascertained. They calculated the sensitivity and specificity of each morphological form in their diagnostic yield. (31)

In 1992 Offringa et al had attempted to analyse the percentage of dysmorphic red cells in the urine sediment and their mean corpuscular volume as a discriminative tool to differentiate glomerular and nonglomerular causes of hematuria. They conducted a literature search to critically analyse the discrimination criteria put forth by various authors to discriminate between glomerular and nonglomerular causes of hematuria. 21 published studies were put to analysis and they concluded that the diagnostic value of urinary dysmorphic red cells with their mean corpuscular volume is of least importance. (34)

In the same year Janssens et al reported the feasibility of indirect immunocytochemistry staining by antiserum against the human Tamm-Horsfall protein that coats the urinary red cells of glomerular origin. (35)

3.6. Morphological forms included in glomerular red cells:

Among the various attempts to describe the morphology of dysmorphic and isomorphic red cells, Birch and Fairley pioneered in their attempt. They described the various dysmorphic erythrocyte morphologies as follows:

- Cells having a small phase dense bleb extruded out of the cell membrane.
- Cells which have ruptured to lose its cytoplasm.
- Cells with granular deposits of phase dense material within the inner cytoplasmic membrane.
- Cells with intracytoplasmic coalesced phase dense deposits
- Cells devoid of limiting membrane.
- A ‘doughnut’ cell with cytoplasmic extrusion at the periphery.
- A ‘budding’ cell with linear deposit of phase dense material in the region of cell membrane.

They also describes the conventional morphology of red blood cells in nonglomerular hematuria as having normal haemoglobin content, while the other morphological forms included ‘ghost cells’ and ‘crenated cells’. (22)

Further in 1991 Roth et al described the dysmorphic erythrocytes (Figure 1) as annular forms of erythrocytes with central defect that appears as a punched out hole, cells with vesicular morphology having diverticula like membranous protrusion and occasional destroyed red cells. He described the erythrocyte with double contour, thorn apple morphology, bizarre rugate forms, club shaped and hooded forms as potential morphological variants of isomorphic urinary red cells suggestive of nonglomerular etiology. (27)

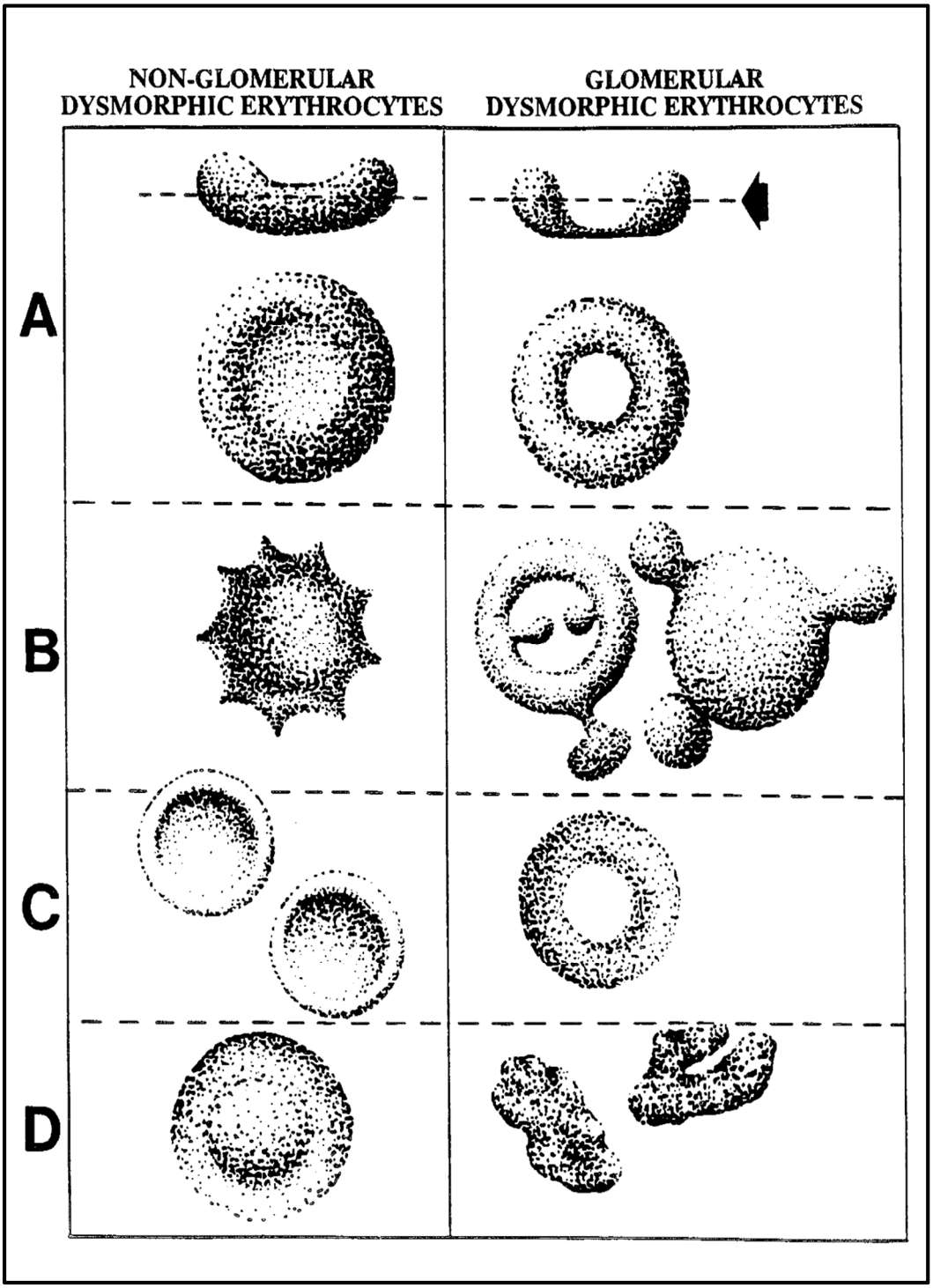


Figure 1: Morphological variable forms of glomerular and nonglomerular erythrocytes described by Roth et al [27]

Further in 2005 Nagahama et al attempted to classify the dysmorphic red cells by involving a population of 45 patients with glomerular disease. D1 cells

included the population of erythrocytes with ring-like morphology with severe loss of cytoplasmic colour and having membranous protrusions or blebs. Those doughnut like cells with moderate loss of cytoplasmic colour along with blebs and protrusions were tagged as D2 cells. The doughnut-like cells with mild loss of cytoplasmic colour and without protrusions or blebs were classified as D3 cells. The study concluded that D3 cells are indicative of glomerular disease with a high degree of sensitivity while D1/D2 cells were indicative of severe glomerular injury. (36)

In 2012 by Tesser et al reported that in addition to dysmorphic and isomorphic red blood cells, other types of erythrocytes such as anisocytes, sickle cells, elliptocytes, poikilocytes and dacryocytes are found in centrifuged urine specimen of patients with hematuria. (37)

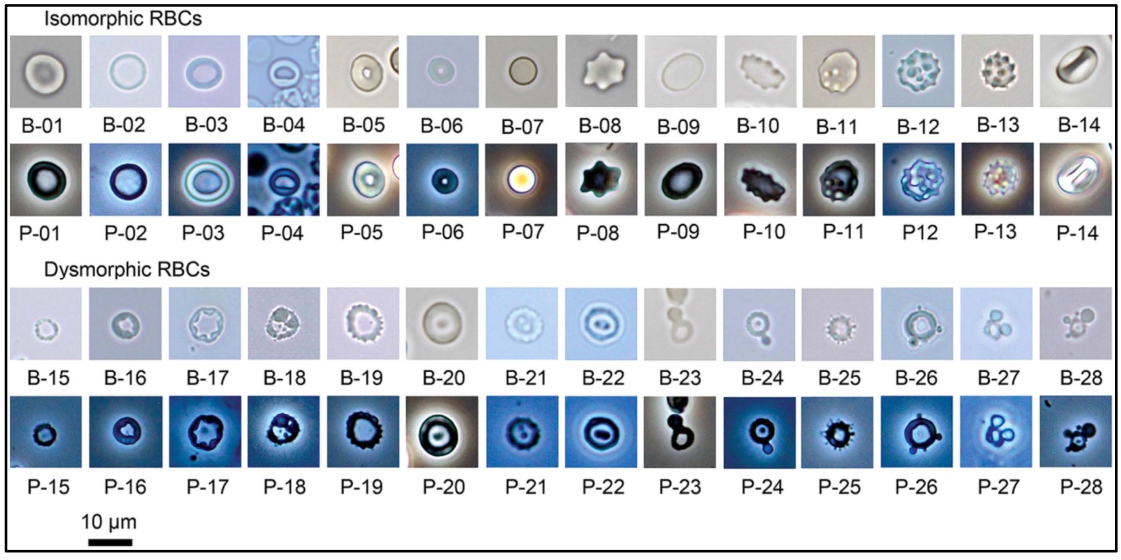


Figure 2: 28 types of isomorphic and dysmorphic RBCs detected using a bright field microscope with results comparable to phase contrast microscope images, Yu Chu-Su et al [38]

In a recent attempt to enhance the detection of dysmorphic red blood cells and renal tubular epithelial cells with a modified urinalysis protocol by Yu Chu-Su et al, a total of 28 types of isomorphic and dysmorphic red blood cells were detected using bright field microscopy (Figure 2) with the results comparable with that of phase contrast microscopy. (38)

The various morphological forms of dysmorphic red cells described in literatures includes:

- Ring form (Figure 3): Most common form where the entire cell volume is arranged in a peripheral ring, thereby providing a dough nut like appearance to the red cell. The centre appears punched out with a sharp inner contour.
- Vesicular form (Figure 4, 5): Vesicles are phase dense protrusions of varying sizes that project from the outer surface or the inner surface of the red cell.
- Ruined forms (Figure 6,7,8) : Severely distorted cell with occasional cells displaying rupture of membranes

Morphological isomorphic red cells include:

- Double rim forms (Figure 9, 11, 12): Cells with thin double rim lacking central hole.
- Spiked forms (Figure 10): Crenated red cells with irregular borders.
- Discoid cells (Figure 13): Red cells appearing like pale discs
- Ghost cells (Figure 14): red cell devoid of haemoglobin.

MORPHOLOGICAL FORMS OF DYSMORPHIC RED CELLS

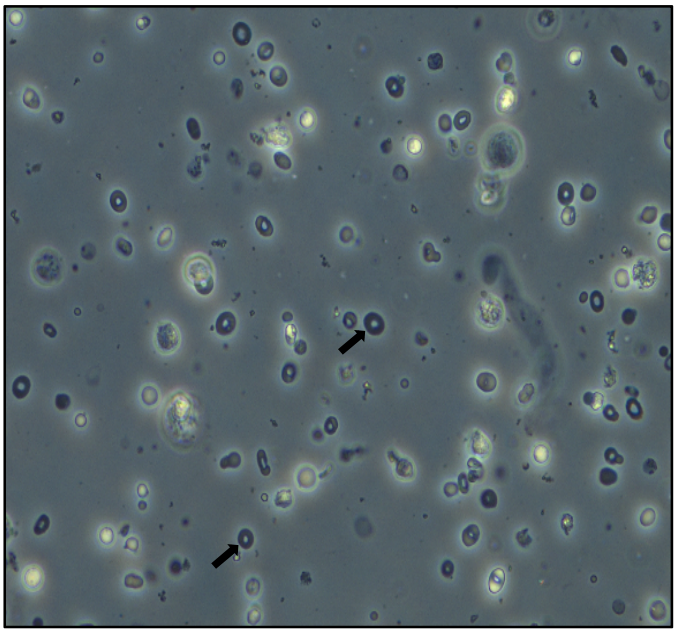


Figure 3: Ring form with doughnut appearance

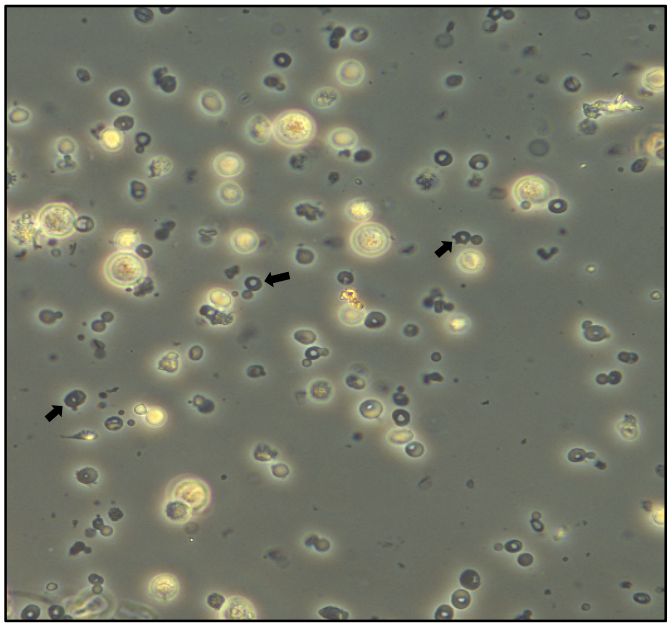


Figure 4: Phase dense forms with doughnut appearance and vesicles

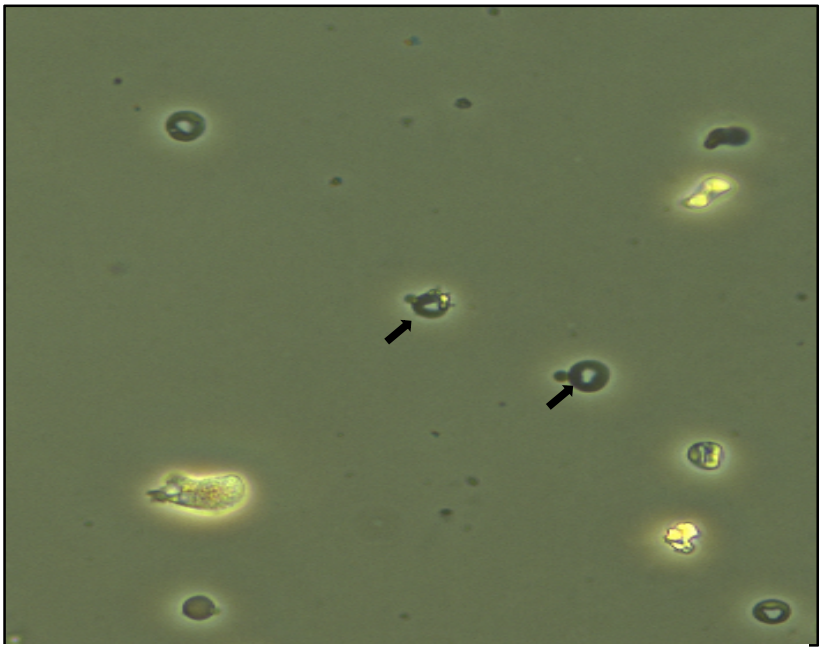


Figure 5: Vesicular forms: Various degrees of membrane protrusions seen in isolation or combination with ring forms.

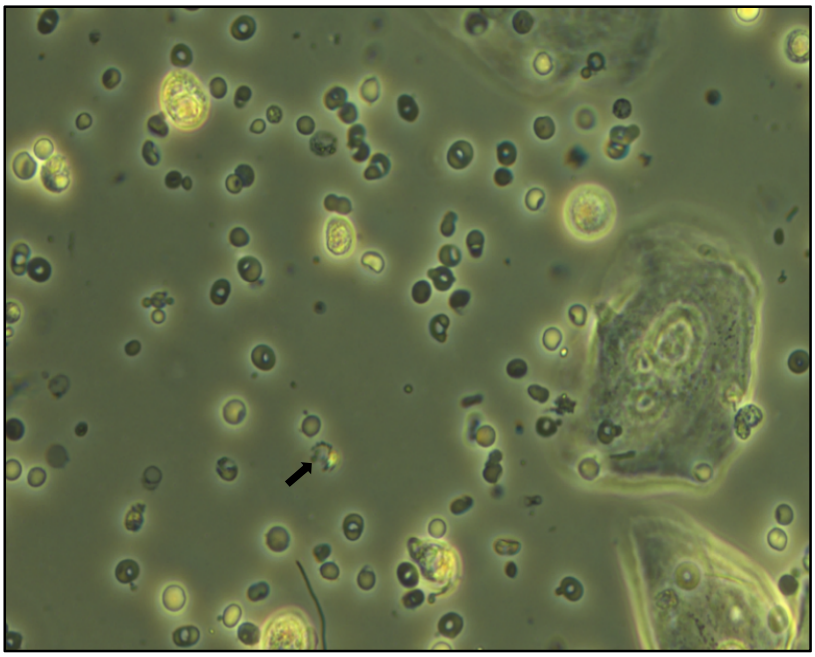


Figure 6: Ruined form: Distorted red cells with mild degree of membrane destruction

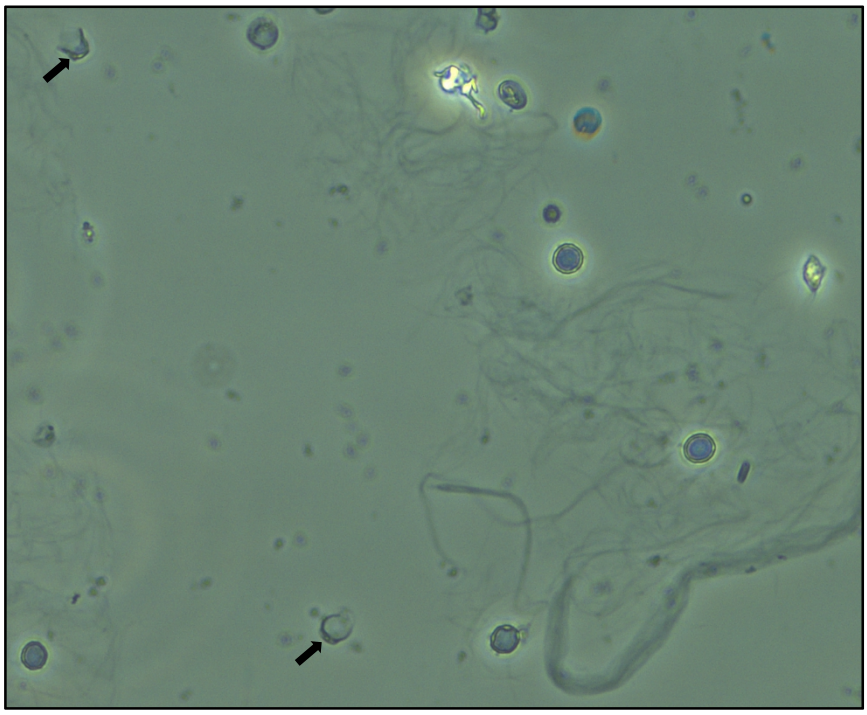


Figure 7: Ruined cells: Red cells with loss of cytoplasm

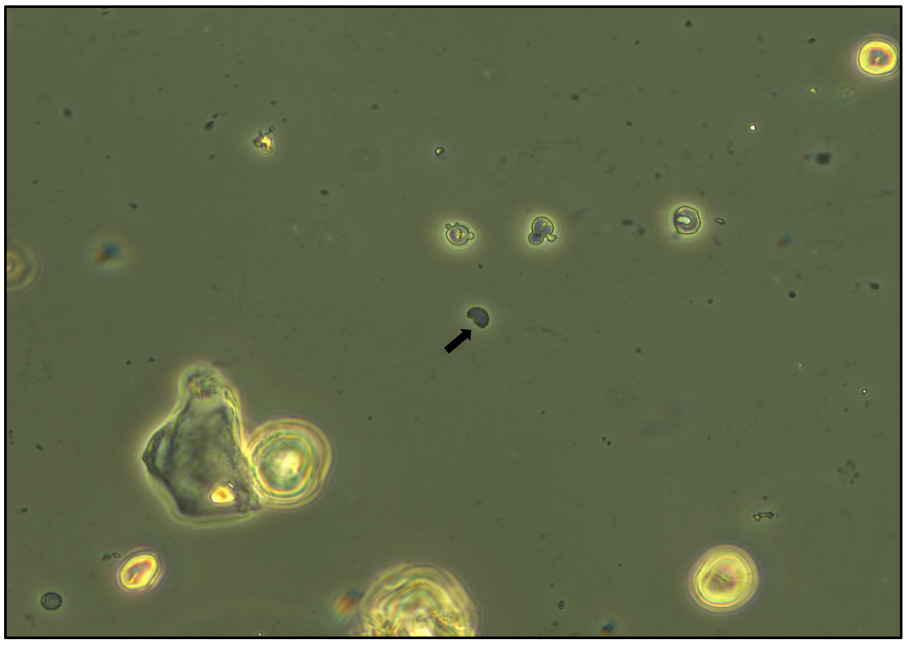


Figure 8: Ruined forms: Glomerular red cells with loss of limiting membrane

MORPHOLOGICAL FORMS OF ISOMORPHIC RED CELLS

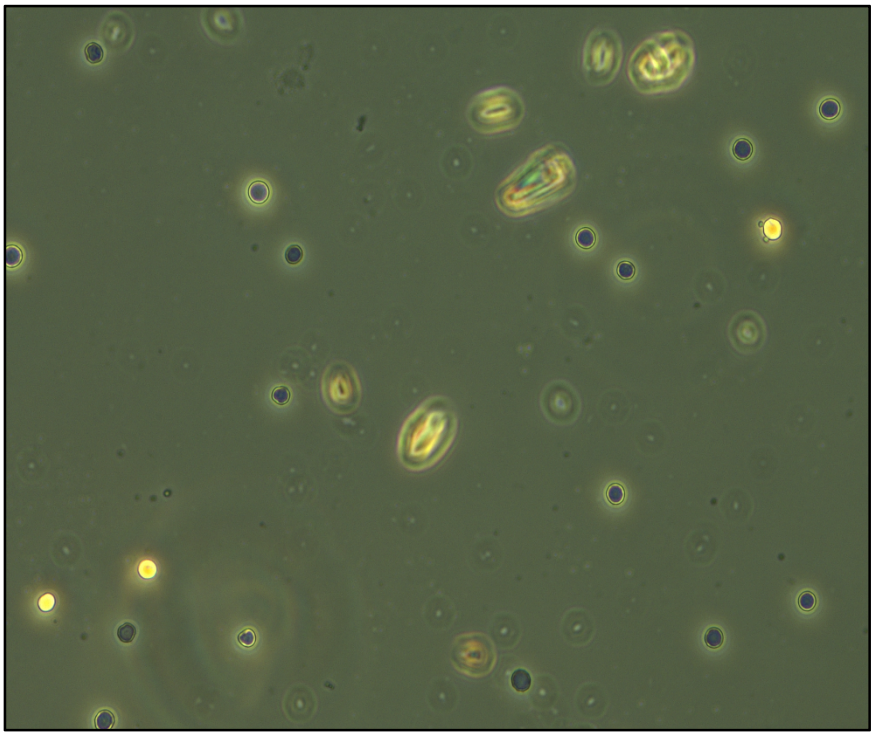


Figure 9: Double ring forms

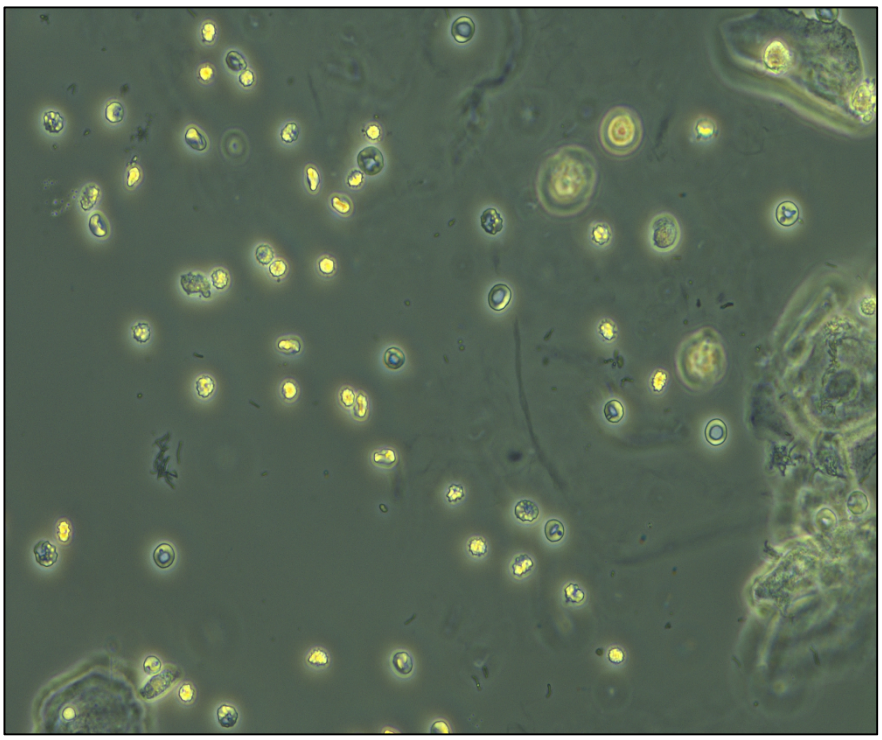


Figure 10: Spiked forms

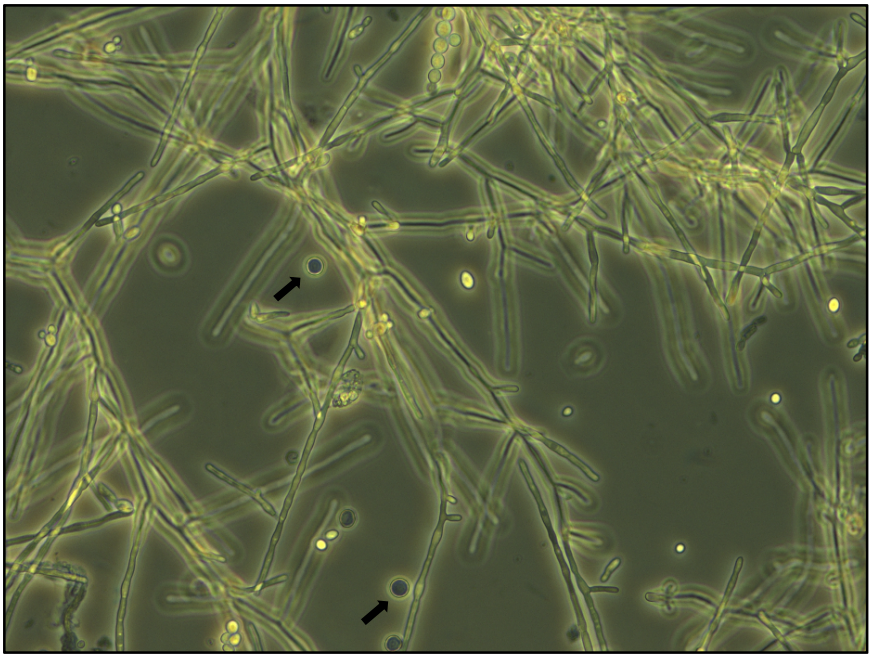


Figure 11: Double ring forms with fungal hyphae

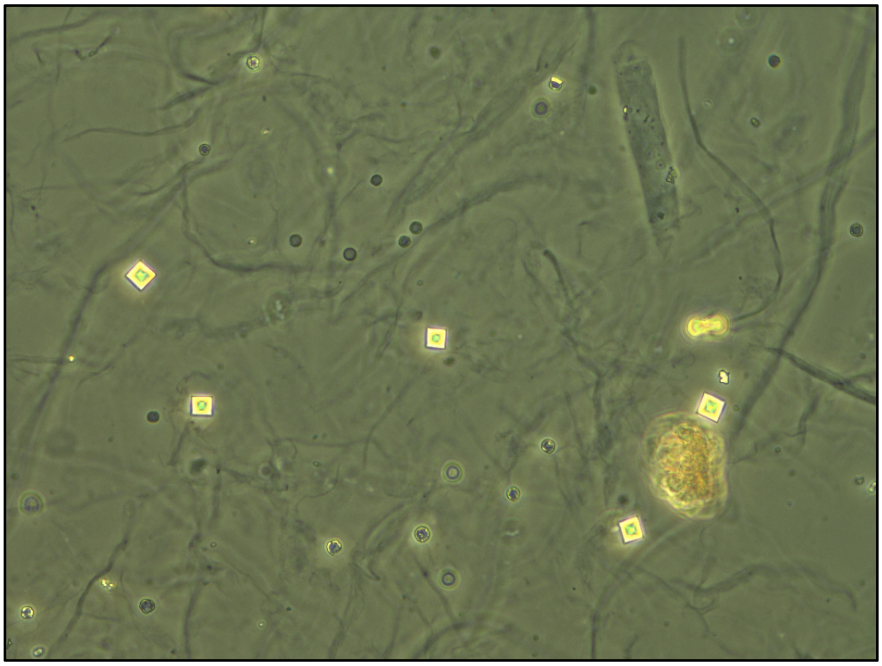


Figure 12: Isomorphic red cells with Calcium oxalate crystals

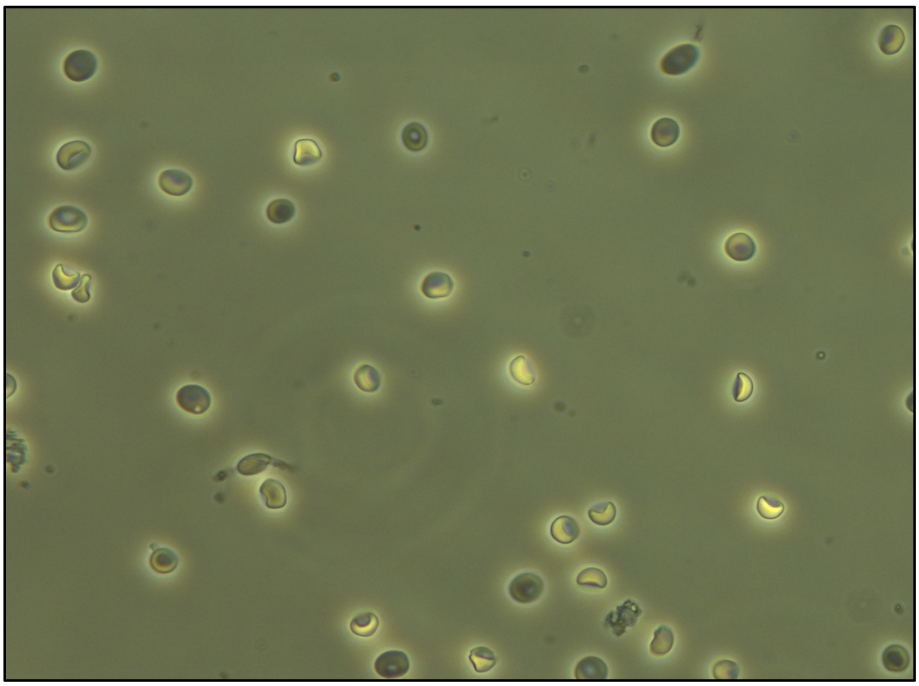


Figure 13: Discoid cells

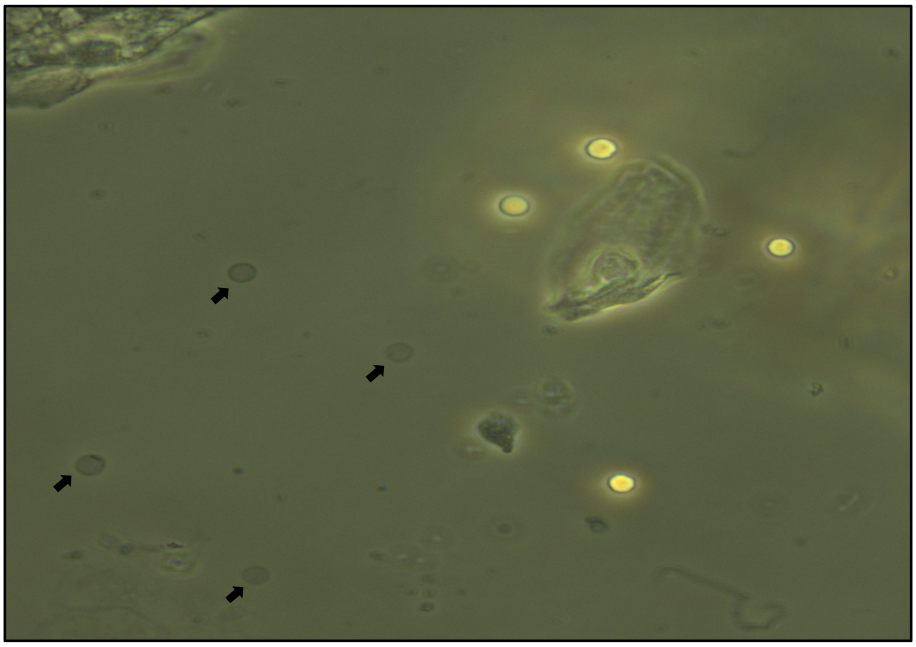


Figure 14: Ghost cells

3.7. Pathogenesis of dysmorphism:

There had been attempts to find the etiology for the morphological alterations happening in red cells in cases of glomerular disease. Mechanical damage sustained by the red blood cells while entering the glomeruli and osmotic injury occurring during the passage through the renal tubules has been documented as the etiopathogenesis in the formation of dysmorphic red cells. (39–41) Pillsworth et al in 1987 had attempted to quantify the dysmorphic red cells by phase contrast microscopy to assess the utility of the same as a screening tool. In the same study they attempted to investigate the pathogenesis of dysmorphism by finding an association with osmolality, pH and urea nitrogen concentration. They found that the percentage of dysmorphism was not modified by these factors over the physiological range. They proposed the possibility of red cell membrane damage on passing through the glomerular basement membrane and the effects of inflammatory mediators released from the neutrophils as the causes for dysmorphism. (42)

In 1992 Kitamoto et al in an attempt for finding the cause of morphological alterations in RBCs in urine, conducted an in-vitro testing simulating the process of concentration of urine along the nephron. They suspended the red cells in a phosphate buffer where it was exposed to three sequential pH and osmotic gradients. It was observed that in glomerulonephritic patients, dysmorphism of red cells was noted almost 5 times than as frequently in acidic urine than alkaline urine, there by proving that dysmorphism occurs as the red cells pass via the tubules where the urine is getting concentrated.(43)

Concurrently similar studies were done to assess the effects of osmolality, pH, sodium, potassium, calcium and urea concentrations on normal venous blood simulating the passage of red cells through the renal tubule by sequentially treating them with fluids of varying concentrations. They concluded that dual injury is required to produce dysmorphism, the first being the passage through glomerular basement membrane and second being the osmotic injury during the passage through hypotonic tubular segment.(44)

In 1999, Roth et al suggested that the morphological alterations can be due to the passage of red cells through altered glomerular clefts. Other reasons attributed were osmotic variations in the conducting and presence of toxic enzymes released secondary to inflammatory process. (27)

Studies have also observed a time and dose dependant changes in the red cell membrane when exposed to the haemolytic red cell lysate. This could explain the reason for lesser degree of dysmorphism in patients with gross hematuria as the effect of haemolytic and osmotic factors on the individual red cells will be markedly reduced when too many red cells are present in the tubular system. (45), (46)

3.8. Phase contrast microscopy:

Figure 15: Leica DM 2000 microscope with phase contrast adjustment

Phase contrast microscope (PCM) invented by Frits Zernike, the Dutch physicist in 1934 is an optical technique with contrast enhancement. The principle of phase contrast microscopy can be explained with the wave theory of light. The light rays are slowed down while passing through an object when compared to air. This depends on the thickness, light absorbance and refractive index of the object through which the light passes through. When all the waves are moving in ‘phase’ all the waves add up to provide a maximum intensity. If some waves are cut off from entering the specimen, then the light intensity observed will be less. When the equal number of waves are in phase and out of phase, the waves mutually get cancelled there by reducing the intensity to zero.

The phase contrast microscopy works with the principle that the best contrast is obtained when the light is retarded by one quarter of its wavelength. (Figure 16)

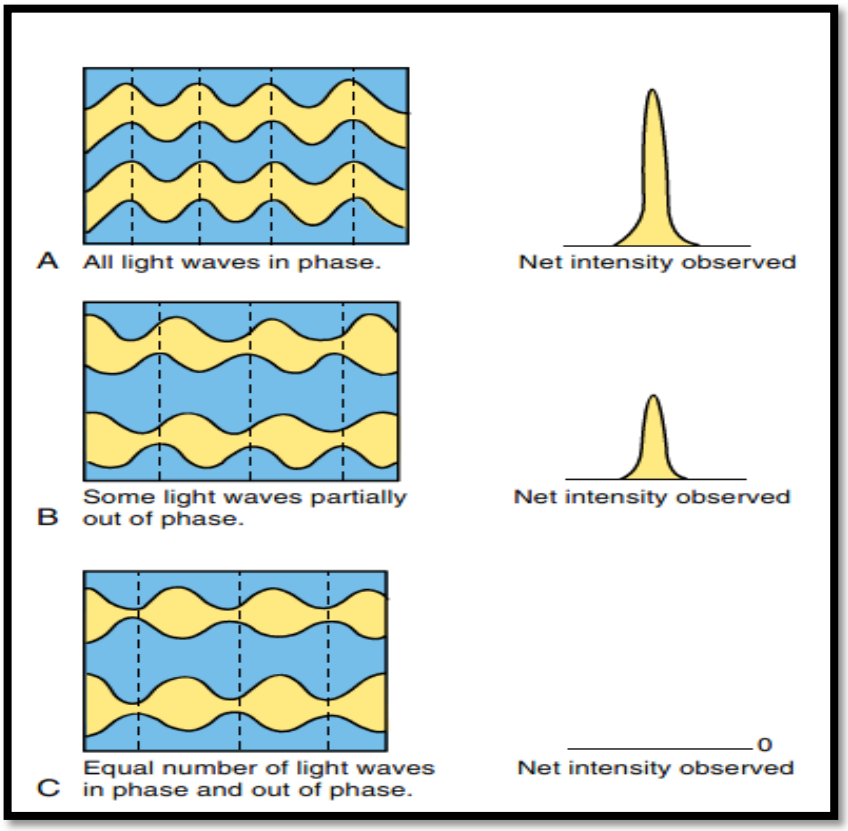


Figure 16: The effect of the phase of light waves on the light intensity (47)

This defines the working of phase contrast microscope which is based on the principle of contrast enhancement of transparent and colourless objects by influencing the optical path of light.

A bright-field microscope is fitted with a phase-contrast objective lens and a matching condenser to convert it into a phase contrast microscope. Phase lenses are fitted within the objective and the condenser which appear as ‘targets’.

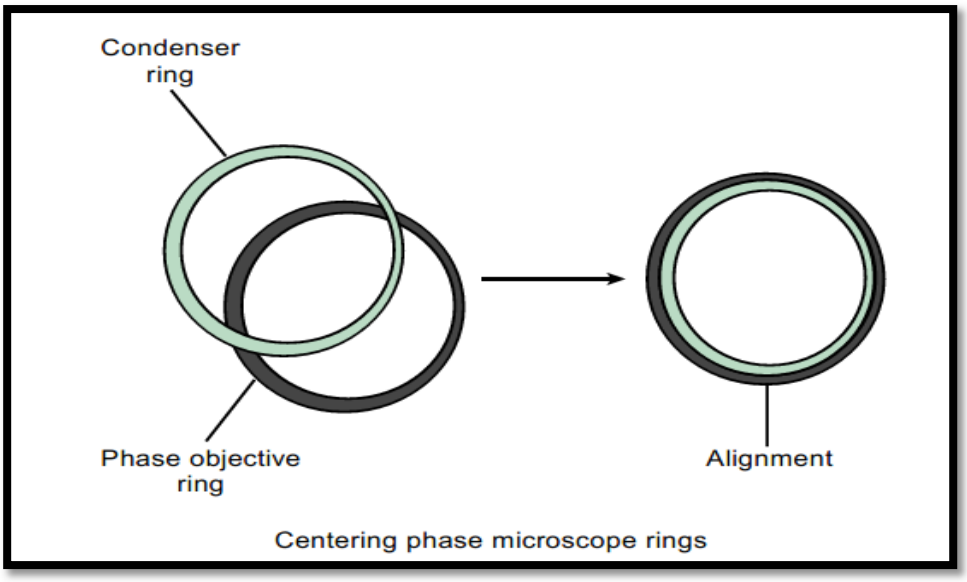


Figure 17: Phase-contrast ring adjustment.[47]

Phase rings are adjusted to provide an optimum phase contrast. (Figure 17) An annular diaphragm which resembles a target is attached to the condenser or below it. The ring attached to the condenser or below it allows the light to pass only through it there by creating a linear path. The second ring in the objective lens which acts as the phase shifting ring retards the light falling on the objective lens by one quarter wavelength. The light ray which passes through the phase ring attached within the condenser creates a halo around the object. This light then passes through the phase shifting ring which shifts the light by one quarter out of phase. All the waves are recombined in order to produce differing degrees of contrast in the specimen range. This further enhances the visualization and clarity of the object based on their refractive indices. (48), (47)

On evaluation of unstained specimens, the objects with low refractive index are more visually enhanced. Hence the discovery of phase contrast

microscopy has revolutionized the investigation protocol for the patients presenting with hematuria.

De Santo et al in 1987 studied 168 patients aged 2-75 years with established hematuria to study the correlation between red cell morphology and final diagnosis and also to quantitate the amount of dysmorphic red cells so as to find an optimum level for diagnosing glomerular pathology. They found a sensitivity and specificity of 96 and 93% respectively for dysmorphic red cells in predicting glomerular etiology. Whereas phase contrast analysis had a sensitivity and specificity of 100 and 98% respectively in detecting isomorphic red cells to predict nonglomerular pathology. (32)

In 1993 Ahmed et al studies the value of urinary erythrocyte morphology in diagnosing glomerular and nonglomerular haematuria using phase contrast microscopy in 105 patients who presented with significant hematuria. The sensitivity, specificity and positive predictive values were 93.6, 97.7 and 98.3% respectively. The positive predictive value for determining nonglomerular hematuria with isomorphic red cell population was 96.7%. There was a mention about the mixed population which was 5 among the 105 subjects who had both glomerular and nonglomerular diseases. They concluded that dysmorphic and isomorphic red cell analysis by employing a phase contrast microscope is a simple, non-invasive and inexpensive diagnostic tool which can distinguish patients into glomerular and nonglomerular arms for further therapeutic management. (49)

In 2011 Sultana et al studied the morphology of urinary erythrocytes by phase contrast microscope as a diagnostic aid in detecting glomerular hematuria. Employing a total population of 120 patients with hematuria and proteinuria they attempted to evaluate the presence of G1 cells and dysmorphic cells by phase contrast microscope to provide a cost effective and low risk technique into the diagnostic algorithm. The results were compared to the final histopathology report of renal biopsies to diagnose the glomerular etiology. Phase contrast microscope could recognize dysmorphic red cells with a sensitivity and specificity of 92.7 and 100% respectively, while G1 cells were identified with a sensitivity and specificity of 97.6 and 100% respectively. The study concluded that the percentage of G1 cells were superior to dysmorphic red cells in diagnosing glomerular pathology. They put forth the utility of phase contrast microscopy in detecting G1 cells and dysmorphic red cells with a high degree of sensitivity which can guide clinicians in the identification of the site of hematuria using non-invasive techniques. (50)

3.9. Automation in urinalysis

Urine analysis is one of the most frequently requested tests in clinical laboratory. Though phase contrast microscopy has been considered as gold standard for detecting dysmorphic RBC population, they suffer certain disadvantages like subjective element identification, poor reproducibility, lack of standardization and time consuming labour intensive process. Hence automation was introduced in the field of urine analysis to improve the

productivity and increase the reproducibility. They were also intended to increase the efficacy for laboratory staffs by allowing the highly skilled technologists to manage multiple tasks simultaneously. The diagnostic platform developed with the introduction of Yellow IRIS which functioned on the basis of microscopic particle identification. Further in the series Sysmex UA series was added which functioned on the basis of the principle of effluent cytometry. (51)

Introduction of automated urine flowmetry has revolutionised the diagnostic acumen by providing a quick and prompt treatment. As uncentrifuged urine is directly fed into the machine for analysis, the time spend for handling and preparing concentrated urine sediment for manual microscopy was reasonably reduced. This also provided the benefit of avoiding exposure to the potential biohazards. The automation in urine analysis provided increased standardisation in urine reports as well as definite reduction in transcription errors as the analysers were interfaced into a LIS system. Urine analysis data can be stored in the devices for quite a long time which can also be retrieved out for various purposes. In spite of much advances in the field of automation application of urine analysis is much lesser than automation in hematological analysis.

It was in 1986 Shichiri et al introduced the use of auto-analyzer to examine the red cell morphology in the diagnosis of hematuria. They plotted a volume distribution curve for urinary red cells where the glomerular red cells showed a small volume distribution while the non-glomerular red cells had a

normal to high volume distribution. The authors suggested the use of automated analyzer which warranted the use of electronic particle size analyzer and gave highly reproducible results. The method had a high degree of sensitivity and specificity and the results can be achieved with minimum effort and good clarity. (52), (53)

In the diagnosis of glomerular hematuria by employing automation, one of the attempts were made by Dinda et al in 2001. They did the image cytometric measurement of hemoglobin content of urinary erythrocytes by employing automated image analysis system in the form of integrated optical density (IOD). 16 bit images were captured and the red cell parameters like area, area equivalent diameter, perimeter and integrated optical density were assessed. The study found that the red cell diameter ranged from 3.65 to 6.23 micrometer in cases of glomerular hematuria, where as it was between 5.25 and 8.59microns in non-glomerular hematuria. It was also concluded that all the parameters studied were higher in non-glomerular hematuria. (23)

3.10. Automated urine analyser Sysmex

Figure 18 Sysmex UX-2000 automated urine analyser

Sysmex introduced the world's first fully automated urine particle analyser in 1995 which transformed the visual urine analysis from being a time consuming and labour intensive procedure. Further in 1998 Sysmex co-corporation launched the fully automated series of Sysmex UF analysers which performed the routine urine formed element analysis. Sysmex UF-100 was introduced in the late 20th century which employed flowmetry and impedance detection to identify the morphology and count the formed elements in urine. Sysmex UF-100 system was developed with a processing capacity of 100 urine specimens in an hour. For automated particle analyser, the UF-1000i analyser requires 4ml of sample while if the instrument is used in the manual mode only

1ml of urine is needed. Urine samples which were aspirated into the analyser were diluted and stained by fluorescent dyes, phenanthridine staining the nucleus and carbocyanine staining the cytoplasm. These stained particles were allowed to pass via an argon beam and a pair of electrodes.

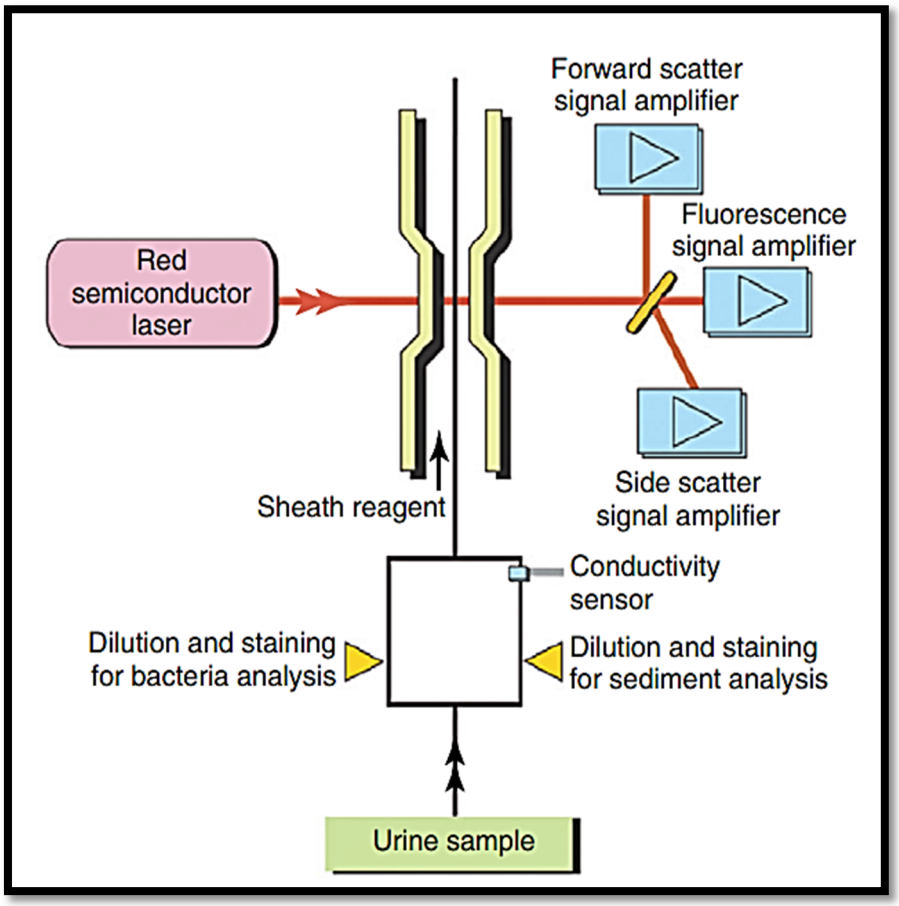


Figure 19: Principle of urine particle analysis in the Sysmex [48]

Particles in urine are oriented in a single file by flow cell and dynamics of laminar flow. (Figure 19) As each channel passes through the flow cell, it is analysed by semi- conductor laser and further the particles are classified on the basis of forward scatter, impedance signals, adaptive cluster analysis, fluorescence staining characteristics and side scatter. These are digitally

recorded by the inbuilt device there by providing a volume histogram and scatter gram for the red cells. Results were also presented as cells per microliter or cells per field of view. The urinalysis flow cytometer provides impedance histogram with data on volume of red blood cells, which provides the information regarding morphological changes arising from passage of red blood cells via the glomerular capillaries. (54)

Initial attempt for evaluation of Sysmex UF-100 automated urine analyser was done by Jonathan et al by comparing continuous counts of microscopic elements from the UF-100 with ranges of cells from manual microscopy performed on centrifuged urine.

Employing a population of 98 patients Hyodo et al in 1999 analyzed the diagnostic efficacy of automated urine flowmeter by analyzing the size and fluorescence intensity. Of the 98, 31 were of glomerular and 67 were of nonglomerular etiology. The samples were analyzed on the flowmeter to establish a criteria based on the results obtained. The set points for glomerular and nonglomerular hematuria was set as 126 and 84 respectively. Based on their study the cases in which ≥80% of all RBC forward scatter intensities ≤126 and <80% of red cells with forward scatter intensities ≥84 were representative of glomerular type of hematuria. The samples in which ≥80% of forward scatter intensities ≥84 and <80% of all red blood cells have FSC intensities ≤126 were regarded as of nonglomerular etiology. All the samples were subjected to analysis by flow cytometry and microscopic analysis and the results were compared to the final diagnosis. The automated urine flow cytometer was able

to recognize glomerular red cells with a sensitivity and specificity of 90.3 and 92.5% respectively with the above set discrimination criteria. The results of microscopy was also compared and it was found to have a sensitivity and specificity of 83.3 and 93.3% respectively. The also attempted to compare the flow cytometry results to the microscopy assuming that the results obtained are true. A sensitivity and specificity of 95% and 93% were obtained for flow cytometry diagnosis when compared to the microscopy results. The second arm of the study was to evaluate the validity of the criteria. For this 109 patients were allotted and UFCM was found to have a sensitivity and specificity of 100 and 86.6% respectively in diagnosing glomerular hematuria. (55)

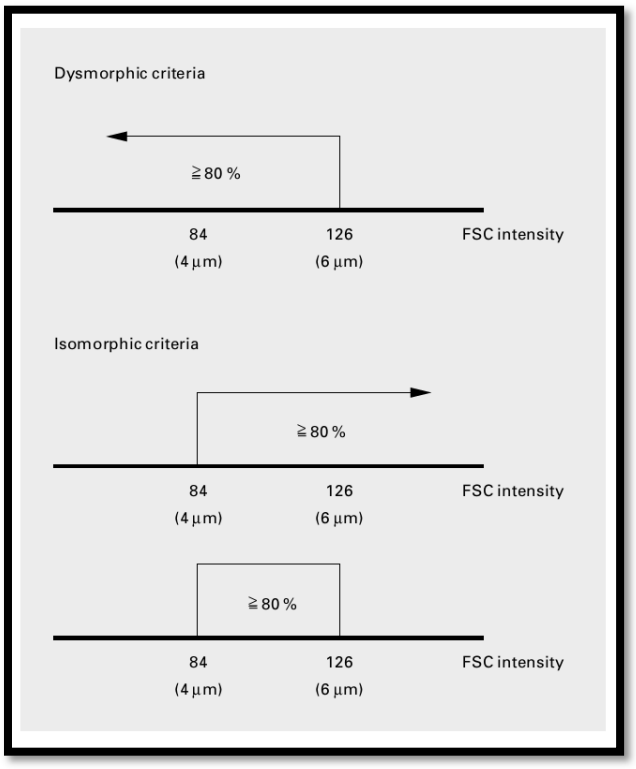


Figure 20: Kitasato University Kidney Centre criteria [55]

In 2001 Apeland at al compared the diagnostic capability of bright field microscopy with Sysmex UF-100 in their ability to differentiate the glomerular

and nonglomerular diseases. Employing a study population of 79 patients, the adopted the Kitasato criteria for further categorising the erythrocyte volume histogram obtained by Sysmex UF-100.(55) The criteria defined the glomerular distinction point for erythrocyte volume as ≤ 126 channels (ch) and nonglomerular discrimination point as ≥ 84 channels (ch), (i.e. erythrocyte diameter of 6 and 4um respectively). If more than 80% of erythrocyte volumes are ≤ 126ch and less than 80% are ≥ 84ch the hematuria was considered as glomerular. If more than 80% of erythrocyte volume are ≥ 84ch the hematuria is considered as nonglomerular. If less than 80% of erythrocyte volumes are ≤126ch and less than 80% are ≥ 84ch, the hematuria was considered mixed. In cases with a doubtful morphological picture, the minor criteria were employed to discern the source of hematuria. The presence of small round cells as of renal tubular cells and pathological casts indicated a glomerular pathology while the presence of leukocytes, bacteria or yeast indicated a nonglomerular pathology. The study reported that Sysmex UF 100 had a sensitivity and specificity of 83% and 94% in detecting nonglomerular bleeding with positive and negative predictive value of 95 and 78% respectively. At the same time the bright field microscopy had a sensitivity and specificity of 79 and 90% respectively with a PPV and NPV of 93 and 74% respectively. Hence they suggested that automated flowmetry can be used to differentiate between glomerular and nonglomerular diseases. (56)

Jiang et al studied the urine particles by analysing the diagnostic capability of Sysmex UF-1000i and urine flow cytometer, dipstick and visual

microscopic examination. The study was intended to set an optimal strategy for urine analysis in clinical practice. Employing three diagnostic modalities they evaluated 1631 urine samples and compared the results with visual microscopic examination with a magnification of 400x (10c ocular times, 40 x objective). Jiang et al concluded that it was Sysmex UF-1000i a better diagnostic aid as it was able to provide reproducible measurements of urine particles in a clinically relevant range.(57)

Koo et al in 2016 attempted to analyse the diagnostic impact of dysmorphic red blood cells in urine from an urologist's perspective. The analysis was conducted on 411 consecutive patients in whom the freshly voided samples were analysed for hematuria with Sysmex UF-1000i analyser and was categorised into 3-5, 6-10, 11-20 and ≥20 red blood cells/hpf. For all the samples percentage of dysmorphic red cells were calculated using phase contrast examination of urine samples. A cut off percentage of 40% was determined to categorise the results as glomerular and nonglomerular. The final diagnosis was determined in all the patients by clinico-pathological evaluation including history, physical examination, renal function tests, and cytological evaluation of urine, cystoscopy, radiological imaging and renal biopsy. They found that the median percentage of dysmorphic red cells were high among patients with glomerular diseases when compared to those with urological illnesses. Even though they utilised the automated analyser for categorisation of degree of hematuria, the Sysmex was not used to analyse the presence of dysmorphic red cells. (58)

Further modifications were added on to the array of automated urine analysers where the UX-2000 (Sysmex Corporation) was introduced as a fully automated integrated urine analyser that can evaluate all physical, chemical and sedimentary properties of urine. Sysmex UX-2000 is made up of 2 analysis components. The chemical (CHM) analysis component analyses the physical and chemical characteristics of urine. The flow cytometry (FCM) analysis component analyses urine sedimentary content. All of the measurements are presented by the software as a scatter gram. The Sysmex UX-2000 provides an automatic count of the components which are quantifiable, which includes erythrocytes, leukocytes, hyaline casts, epithelial cells and bacteria. Pathologic components which are non-quantifiable are also detected and flagged by Sysmex UX-2000 which includes crystals, yeast-like cells, small round cells including renal tubular cells, transitional epithelial cells, and oval fat bodies, spermatozoa, mucus, and pathological casts.(59) With a full-fledged panel for particle analysis, UX-2000 serves as a fully automated integrated urine analyser that can carry out physical, chemical and sedimentary analysis of urine in a single efficient device. The aspirate volume is 2.2 ml of urine, but requires a minimum sample volume of 5.0 ml. 200 samples can be analysed for chemistry alone, 100 samples for flowmetry alone and 150 samples for chemical and flowmetry combined analysis per hour.

UX-2000 has proven to be a compact device that works in fresh samples without the need for centrifugation, hence preserving all particles. However, this device needs a higher urine volume in automatic mode. This can pose some

difficulties for analysing paediatric urine samples, although this short coming can be simply resolved by switching to manual mode. For daily practice UX-2000 needed more exhaustive maintenance which if not met, could lead to workflow interruption and consequently prolong the response time to get the results. (60)

Even though the study does not comment upon the efficacy in detecting red cell morphology, Khejonnit et al employed a comparative analytical study involving Sysmex UX-2000 and manual microscopy to establish optimal criteria for the parameters like RBC, WBC, EC, bacteria, yeasts, hyaline casts, pathological casts, crystals and SRC. The review rate was 54.1% and false negative rate was 2.8%, whereby they concluded that Sysmex UX-2000 cannot properly replace the technologists especially in cases of abnormal urinalysis and a viable option is to combine both Sysmex UX 2000 and manual microscopic methods to obtain best results. (59)

3.11. IRIS iQ 200 automated urine analyser:

Figure 21: IRIS iQ automated urine analyser [61]

Iris iQ 200(Figure 21) is an automated urine analyser developed by Iris Diagnostics Inc. (Chatsworth, California, USA) which combines several automated subsystems to perform a complete urine analysis through combination of dipstick analysis and imaging based technology.(61)

The iQ 200 Series system auto-identifies and processes specimens in 10 position racks by mixing, sampling and analysing automatically. The system consists of two units, one for physical and biochemical evaluation of urine samples and the second being the automatic particle detector and counter. The two modules are interlinked by cable communication which is in turn connected to the PC4 analysis processor/result processor which is the workstation for reporting the specimen composition results. The automated microscopy module is linked physically and electronically to the automated chemistry analyser which works hand in hand. Specific gravity is estimated by mass gravity method,

chemical analysis by standard reflectance spectrophotometer and urine microscopy by an automated intelligence microscopy system.(5) This automated urine microscopy system presents the specimen sandwiched between enveloping layers of lamina to a microscope coupled to a CCD (charge coupling device) video camera which captures 500 images in 884 x 680 µm fields with 068µm resolution. This lamination positions the specimen exactly within the depth of focus and field of view of the objective lens of the microscope. Lamination is the planar equivalent of axial hydrodynamic focusing, used to position cells in certain types of blood cell counters and flow cytometers. It has the added advantage of achieving orthoscopic particle orientation, thereby presenting asymmetric particles with their largest profile facing the direction for image capture. Stroboscopic illumination freezes the motion to ensure blur-free images on charge-coupled device camera sensor. (62)

The analyser mixes the sample before aspirating it. An amount of 1ml of urine sample is aspirated into the instrument and 2µL is used for the analysis. Absence of centrifugation being an added benefit minimises the need for manual handling. The aspirated sample is immediately sandwiched within a special fluid called lamina (iQ lamina, IRIS Diagnostics) that flows through the proprietary flow cell. The lamina and flow cell are key to hydro dynamically orienting the particles in urine. This flow path is at a specific depth of focus which enables precise microscopic viewing. The field of view of microscope is coupled to digital video camera and stroboscopic illumination freezes the particles in motion which ensures blur-free imaging. The CCD digital camera captures five

hundred frames from each urine sample and within each frame the individual particles are isolated in different frames. The automated particle recognition (APR) software which works on the basis of neural network technology utilise the size, shape, contrast and texture to classify the particles into different categories. The categories include Red blood cells (RBC), Dysmorphic red blood cells (dRBCs), White blood cells (WBC), White blood cell clumps (WBCC), Squamous epithelial cells (SQEP), Non-squamous epithelial cells (NSE), Bacteria (BACT), Crystals (UNCX), Hyaline casts (HYAL), Unclassified casts (UNCC), Yeast (BYST and HYST), Sperm (SPRM), Mucous (MUCS) and Unclassified (UNCL). On classification based on the user defined release criteria the information is released to the Laboratory Information System (LIS) or is presented to the operator review screen. As the volume of laminar flow chamber is fixed and known, images are counted and related to the volume of urine with high degree of precision which parallels with the manual method of centrifugation and smear preparation. The machine is also equipped with a touch sensitive video screen which eliminates the need for key board entry. The average time required for an experienced user to review the urine analysis results from a single urine sample is estimated as 30 seconds. (5)

The main advantages of IRIS iQ 200 is that it can perform revisions on the instrument screen itself. It obviates the need for manual sediment preparation which is a labour intense task. However, it is necessary to undergo major staff training so that the staff become used to identifying the images shown. (4)

Initial attempts into the analysis of diagnostic capability of IRIS was done in the early 2005 by three different authors. David et al evaluated the performance of Iris iQ 200 by involving a sample of 166 study subjects. The compared the results with the Fuchs-Rosenthal counting chambers. Analysing for the RBCs, WBCs and epithelial cells, he found that there was good agreement between the automated analyser and manual cell counting. Even though the study did not analyse the yield in dysmorphic red cells, they found that discrepancies in the red cell yield was due to abnormal red cell morphologies including dysmorphic and ghost red cells. (63)

In the same year Lamchiagdhase et al conducted the same analysis involving a population of 280 subjects, comparing IRIS iQ 200 to visual microscopy of urine sediments counted in a coverslip according to NCCLS protocol, or in a standardised commercial chamber. Apart from the red cells, white cells and squamous cells they included the formed cellular elements also. The study concluded that there was significant correlation in both systems. However the presence of casts, crystals, bacteria and budding yeasts obviated the need for further categorisation under microscopy. (64)

Lia Alves et al in 2005 evaluated the IRIS iQ 200 the automated urine analyser with respect to linearity and precision and compared the results with microscopic examination of urine sediments and urine strips in a CLINITEK 500 analyser. The study showed highly significant correlation with those of urine sediment (erythrocytes: rho=0.68; $p<0.001$), and urine strips (erythrocytes:

rho=0.67; p<0.001). There was no comparative analysis of the dysmorphic red cell population in that study too. (65)

Linko et al in the subsequent year carried out similar analysis comparing the IRIS iQ 200 with that of results obtained from phase contrast microscopy and routine bright field microscopy. They concluded that the automated analyser could reliably count RBC, WBC and squamous epithelial cells and could successfully identify a fraction of bacteria and renal elements with the machine exceeding or equalling the diagnostic yield of bright field microscopy. They tabulated the sensitivity and specificity for detecting all the cellular and formed elements in urine and found that the automated particle classification alone had a sensitivity and specificity of 73.2% and 88.1% respectively in detecting red cell population whereas reclassification of the detected images by a trained personal had a sensitivity and specificity of 80.2 and 82.9%.(61) The attempts of comparison by multicentre evaluation of Iris iQ 200 automated with haemocytometer cell counts were done in 2008 by Burch et al who found a very good agreement based on slopes and r^2 values.(66)

The first attempt to analyse the diagnostic capability of IRIS iQ 200 automated urine analyser for dysmorphic red cells was done by Broek et al in 2008 who employed 1482 routine samples which were positive in dip stick analysis. They looked for the erythrocytes, dysmorphic red cells, leukocytes, casts and bacteria employing IRIS iQ200 and traditional microscopy. 83 cases with special request for dysmorphic red cell analysis were included in the study. Microscopy and IRIS iQ 200 were able to detect 12 cases with dysmorphism

while 71 were negative. A percentage of 20% was taken as the cut off for categorising the cases as glomerular or nonglomerular. Morphologically distorted dysmorphic red cells in all the 12 cases were categorised under either erythrocytes or unclassified particles, in which case the further categorisation was done by experienced technicians. (67)

In 2012 Bowen et al in the study to compare the Iris iQ200 with manual microscopy as a diagnostic tool for dysmorphic erythrocytes in urine', evaluated 207 urine specimens with suspected glomerular hematuria. The samples were analysed by IRIS iQ 200 followed by manual microscopy by two experienced laboratory technicians. As the iQ 200 could not automatically classify the dysmorphic erythrocytes, two independent and experienced technicians reviewed the images within the category of "normal erythrocytes" and "unclassified" into the category of "dysmorphic red cells". The study put fourth that the IRIS iQ 200 did not provide enough resolution to properly categorise dysmorphic red cells which was better classifiable in microscopy with better resolution. The dysmorphic red cells were categorised into D1, D2 and D3 based on the morphology and the study concluded that the classification of D1 and D2 cells into dysmorphic category did not warrant any diagnostic challenge, while the resolution and contrast was not adequate enough to reclassify the D3 cells which could easily been recognised by phase contrast microscopy. D1 and D2 morphology was described by the author as those cells with membrane protrusions like Mickey Mouse like cells or those with severe to mild loss of cytoplasmic colour. D3 cells were described as the cells with doughnut

morphology or those with other polymorphic forms including discocytes, knizocytes, anulocytes, stomatocytes, codocytes and schizocytes. The study concluded that the iQ 200 cannot be used to reliably detect all forms of dysmorphic red cells and the process is dependent on image reviewing by trained professionals. (68)

In 2015 Henneberg et al tried to compare the manual method and IRIS iQ 200 for optimisation of urinalysis. The study aimed at comparing the results of test strips, microscopic analysis and counts employing 275 urine samples. With regard to red cell morphology, the machine detected 159 samples with red cells of which 155 were of isomorphic morphological pattern and 4 were unclassified, for which the image was not clear enough to reclassify. These 4 samples were reviewed by optical microscopy according to the technique described by Barros Silva et al. There by the author reaffirmed the importance of microscopy over the automated analyser in dysmorphic red cell analysis. They suggested that the implementation of automated urine analysers should be done by taking into consideration of the population being served, availability of skilled technical staff and cost benefit analysis. (33)

Later in 2016 an attempt to compare the diagnostic automated urine analysers was done by Ince et al. who analysed 209 urine samples by two automated image based analysers, Iris iQ 200 ELITE and Dirui FUS-200 in comparison with the manual microscopy for the cellular and formed elements. The study recorded a sensitivity and specificity of 72.7% and 94.9% for Durui

FUS-200 and 75.8% and 92.7% for Iris iQ 200 ELITE in detecting erythrocytes.(69)

Bakan et al studied 153 pathological urine sediment samples with IRIS iQ200 and manual urine microscopy and found out that IRIS i200 has a sensitivity of 90%, specificity of 63%, and positive predictive value of 65% and negative predictive value of 76% for RBC sediment analysis. The analysis for dysmorphic red cell yield was not done. (70)

3.12. Comparative analysis between Sysmex and IRIS iQ 200:

There had been attempts to compare the diagnostic capacity of automated urine analysers with the manual microscopic particle counting. One of the attempts were put forth by Shayanfar et al in 2007 who compared the IRIS iQ 200 automated urine analyser and Sysmex UF-100 flow cytometer with manual microscopic particle counting. A total of 332 specimens were collected and analysed for insoluble urine components. He found out that both automated systems showed limited quality in identification of erythrocytes with a sensitivity, specificity, PPV and NPV of 76, 93, 92 and 78% respectively for Sysmex UF-100 and 70, 98, 90 and 92% respectively for IRIS iQ 200 in picking up erythrocytes. The study did not aim at finding the accuracy among the automated analysers in diagnosing dysmorphic red cells. Still the author suggested that the Sysmex UF-100 could distinguish red cells as glomerular and nonglomerular as the machine distinguishes on the basis of cellular diameter and red cell distribution while the morphological alterations are not considered of any importance. He also raises a probability of low yield of erythrocyte count in

IRIS iQ 200 in cases with abnormal erythrocytes like ghost cells and dysmorphic forms. They suggested the warning system available in Sysmex UF-100 is of great advantage when compared to IRIS iQ 200. (71)

In the subsequent year Mayo et al attempted to compare the various analysers - automated microscopy, flow cytometry and test strip analysers with the existing modality of microscopy. They found the concordance level for each analyser in detecting various elements in urine. Even though they did not attempt to study the dysmorphic red cell yield, the analysers IRIS-iQ 200 and Sysmex UF-100 had a concordance rate of 80% and 70-74% in detecting erythrocytes in urine samples. The advantages sited for Sysmex UF-100 included: better precision for low units of cells, faster analysis, and availability of a scattergram which provides more precise information about red blood cell morphology. Still the results obtained from Sysmex UF-100 required multiple revisions for sediment analysis. They also gave a spuriously high value of red cell count due to the presence of crystals. The IRIS iQ 200 at the same time requires less number of revisions and that too can be done without the sample being reprocessed for microscopic analysis. The processed sample images can be revised to analyze for the abnormal outputs. But the process warrants the need for staff training for proper identification and categorization of images. The inability of IRIS-iQ 200 to flag/generate alarm for the abnormal elements was also considered as one of the disadvantages by the author. (4)

3.13. Characteristics of Sysmex UX-2000 and IRIS-iQ 200

	SYSMEX UX-2000	IRIS iQ200
Particles Identified	Red blood cells, White blood cells, epithelial cells, casts, bacteria, small round cells, yeast like cells, sperm, crystals, pathological casts, mucus, Crystal, YLC, SRC	Red blood cells, White blood cells, bacteria, hyaline casts, pathological casts, crystals, squamous and non-squamous epithelial cells, yeast, white blood cell clumps, sperms, mucus
Principle of analysis	Fluorescence flow cytometry	Flow cell digital imaging with automatic particle recognition software
Required specimen volume	5ml	2ml
Sample throughput per hour	100 (flow cytometry only)	101
Stain	Yes (fluoroscene)	No
Images	None	CCD images
Data storage(memory)	10000 samples including graphics	10000 patient results with images

Table 2 Characteristics of Sysmex UX-2000 and IRIS iQ 200

3.14. Lacunae in the current knowledge

Researches were channelled mostly to assess the morphological alterations in urinary red cells and the performance status of phase contrast microscopy. With the advent of automated processers studies were done to assess the analytical performance of machines in comparison to the final diagnosis, so that attempts can be made to replace the existing modality of phase contrast microscope. Even though there were studies comparing the diagnostic accuracy of urine analysers in analysing formed elements like red cells, leukocytes, casts and crystals there were no attempts to analyse the variation in dysmorphic red cell yield by various analysers. There is not much of study to analyse the performance status of one automated analyser over the other in comparison to the existing gold standard, phase contrast microscopy. Even though Hyodo et al had suggested that Sysmex UF-100 can be utilised as a better screening test which can be used to triage patients with microscopic hematuria, a comparative analysis and determination of a better diagnostic and screening modality is first in the literature.

3.15. Justification for study:

Since there were no attempts to analyse the diagnostic accuracy of automated urine analysers in detecting dysmorphic red cells in urine, the study provides a novel attempt in finding the best machine that can be employed for the diagnosis of glomerular illness and screening. Reading through the literature there was enough and more evidence regarding the morphometric analysis of dysmorphic and isomorphic red cells in urine by employing phase contrast

microscopy. But the attempts to analyse them by automated urine analysers were very few. The published literatures compared the performances of automated analysers, but failed to compare the dysmorphic red cell yield. Hence the present study was intended to be an attempt to fill the lacunae in the research field about this topic.

3.16. Study hypothesis and study design

The study was carried out to compare the diagnostic capabilities of the two automated red cell analysers, Sysmex UX 2000 and IRIS iQ 200 in comparison to the phase contrast microscopy, which was regarded as the gold standard method in urinary dysmorphic red cell analysis. Initially the attempts were done to have a correlation analysis employing the final histopathological diagnosis on renal biopsy. But as the samples obtained during the study period was very less and statistically insignificant, the attempt was not carried forward.

MATERIALS AND METHODS

Study was approved by the Institutional Review Board with the IRB No: 9909 [DIAGNO] dated 05.02.2016 (Form attached in the annexure).

4.1. Study design:

After getting approval from the institutional review board this prospective study was conducted in the Department of Transfusion Medicine and Immunohematology (Clinical Pathology) at Christian Medical College, Vellore, India, in conjunction with Department of nephrology and urology. The study spanned over a period of six months from July 2016 to December 2016.

4.2. Study population:

All the patients sent with request for urine analysis for microscopic hematuria from the Department of Nephrology and Urology were scrutinised and those with a confirmed dipstick testing for blood were included in the study. Those samples were subjected to further analysis. The cases sent with special request for analysing dysmorphic red cells from other departments which had a positive dip stick testing were also taken into the study population. From July 2016 to December 2016, 1,89,279 samples of urine were received at the Department of Clinical Pathology for various pathological testing while 596 samples were send with a special request for dysmorphic red blood cell analysis by phase contrast microscopy. Within the stipulated time period of 6 months the study was conducted incorporating a population of 800 patient samples with microscopic hematuria which fulfilled the inclusion and exclusion criteria listed below.

4.3. Inclusion criteria:

1. All clinically suspected cases of microscopic hematuria which were confirmed by dip stick testing.
2. All clinically suspected cases from other clinical departments with microscopic hematuria detected by dip stick analysis warranting further workup.
3. The cases send with suspected glomerular pathology for phase contrast analysis and with positive dip stick analysis for hematuria.

4.4. Exclusion criteria:

1. All samples with gross hematuria.
2. Samples with red cells <5/ hpf on phase contrast microscopy.
3. Samples which were labelled negative on dip stick analysis for hematuriaeither by Sysmex UX-2000 or IRIS iQ 200.
4. Samples which has showed an intermediate/unequivocal graph, which could not be categorised either into dysmorphic or isomorphic morphology in Sysmex UX- 2000.

4.5. Sample collection and processing:

20ml of freshly voided mid-stream catch urine was received at the department within 4 hours of collection. Samples were transferred into a 9.5 mL Vacutte evacuated urine tube with a yellow cap. The samples from Nephrology and Urology department were categorised for study purpose.

4.6. Dipstick analysis

All the samples were subjected to dipstick analysis in automated analyser to look for presence of hematuria. MEDITAPE II 9U was the urinalysis reagent pads used for determination of blood. It is being utilised for the fully automated integrated Urine analyser Sysmex UX-2000. The test is based on the pseudoperoxidase activity of haemoglobin which catalyses the oxidation of chromogen. The reaction yields a blue colour.

Components: Cumene hydroperoxide and 3, 3', 5, 5' tetramethylbenzidine.

Interpretation of results:

+/-: 0.03-0.05 mg/dl.

1+: 0.06-0.19 mg/dl.

2+: 0.20-0.99 mg/dl.

3+: 1.0 mg/dl and above.

The cases with macroscopic/gross hematuria were not subjected to further analysis. After dipstick analysis, the cases with microscopic hematuria were included in the study. The cases were graded for the degree of hematuria from 1+ to 3+. The information regarding presence and absence of proteinuria was also recorded in all the cases in the study.

Dip stick analysis for hematuria:

The interpreted results for microscopic hematuria was classified into 1+, 2+ and 3+ based on the degree of hematuria.

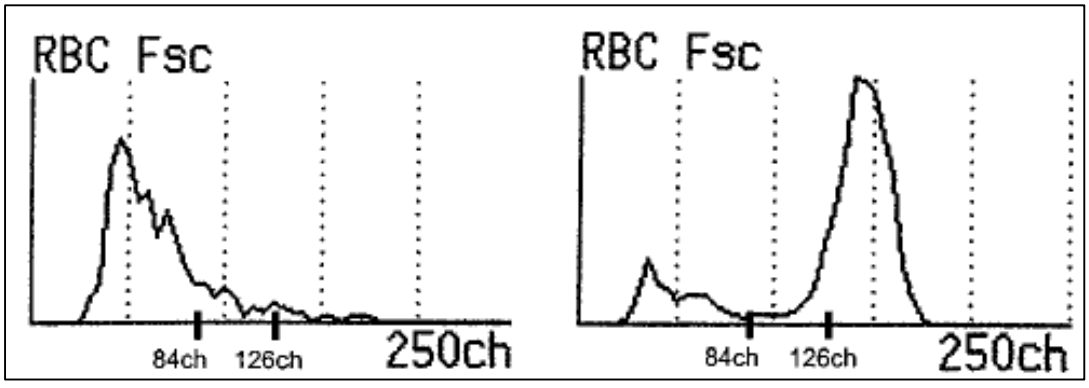
4.6.1. Processing by Automated analyser 1: Sysmex UX 2000

The samples were processed for dysmorphic red cell analysis in the automated analysers, Sysmex UX-2000 (Sysmex, Kobe, Japan) in the next step. The graphical representation of red cell distribution was utilised for further categorisation of cases into dysmorphic and isomorphic by Sysmex UX 2000.

Sysmex UX-2000 graphical interpretation:

Based on Kitasato criteria.(55)

- Glomerular distinction point for erythrocyte volume (Dysmorphic): >80% of erythrocytes with ≤ 126 channels (ch). (i.e. erythrocyte diameter of 6µm)
- Nonglomerular discrimination point for erythrocyte volume (Isomorphic) : >80% of erythrocytes with ≥ 84 channels (ch), (i.e. erythrocyte diameter of 4µm).



***F*igure 22: Graphical interpretation for Sysmex** [56]

All the samples were categorised into either glomerular or nonglomerular etiology based on the graphical representation. All the samples which produced a peak intermediate between the discrimination points for glomerular and nonglomerular red cells were excluded from the study.

4.6.2. Processing by Automated analyser 2: *IRIS iQ 200*

Further the same samples were processed in IRIS iQ (Beckman, USA) for morphometric analysis. The CCD captured pictures were reviewed and further categorised into the pool of dysmorphic red cells by the investigator and the machine automatically calculated the percentage of dysmorphism.

IRIS iQ 200 interpretation:

Images of red blood cells captured by the CCD camera were analysed for the presence of dysmorphism and were categorised into the portal of dysmorphic red cells manually. The red cells were analysed for the morphology based on the catalogue provided pictures of dysmorphic red cells by the investigator. Machine had automatically provided the dysmorphic red cell percentage on adding the dysmorphic red cells into respective portal. Cells like Mickey Mouse cells with membrane protrusion and mild to severe loss of cytoplasmic collar were included in the category. Doughnut forms and red cells with vesicular membranous projections were also included. The cut off for dysmorphism was used as the same as that used for phase contrast microscopy. Those cases with poor resolution of images including the ones automatically placed into the unclassified category by the machine were reclassified to the best of attempts.

Figure 23: Red cells with dysmorphic morphology in IRIS iQ 200

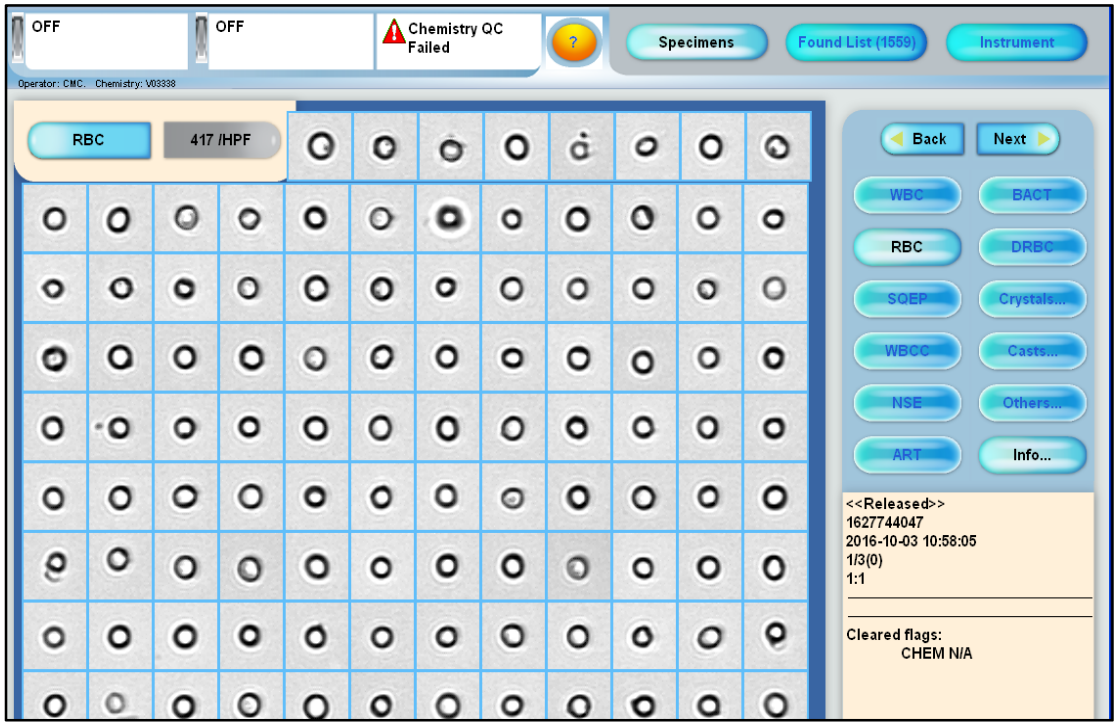


Figure 24: Red cells with isomorphic morphology by IRIS iQ 200

4.6.3. Processing by Phase contrast microscopy:

The samples were prepared for phase contrast analysis as follows: 15ml of urine was centrifuged for 5 minutes at 2500 rpm. 14ml of supernatant fluid was decanted and the sediment was suspended in the remaining 1ml. One drop of this suspension was placed on a glass slide and a coverslip was placed on top of this. The sides of the slides were sealed by paraffin wax. The sediment was further screened at low power magnification by a Leica microscope (Leica DM 2000 with phase contrast) with a phase contrast illumination for red blood cells to analyse the morphological changes. The morphological forms of red cells were noted with quantification of the amount of dysmorphism (red cells per hpf). Counting a population of 100 red blood cells, the percentage of dysmorphism was calculated in each case.

Phase contrast microscopy interpretation:

Samples with red cell count >5/hpf were analysed under phase contrast microscope for the presence of dysmorphism. The red cells were categorised based on the various shapes.

Morphological forms included in glomerular red cells:

- Ring form
- Vesicular form
- Ruined form

Morphological forms included in nonglomerular red cells:

- Double rim form
- Spiked forms

- Discoid forms
- Ghost cells

The percentage of dysmorphic and isomorphic red cells were calculated with the total number of red cell population. The cut off for dysmorphism was taken as 25% based on institution based previous studies. All cases with >25% dysmorphic red cells were included under glomerular pathology. Rest with <25% of dysmorphic red cells were tagged with a majority population of isomorphic red cells and hence with nonglomerular etiology. The red cell population in each cases were categorised and tabulated.

The results of the two automated urine analysers were categorised as either glomerular or nonglomerular based on the above set criteria. The results were compared to the final diagnosis by gold standard phase contrast microscopy.

Information regarding the clinical details of subjects included in the study were obtained from clinical workstation. The information was entered into the clinical research form (attached in the Annexure). The data obtained were fed into the Epidata analytical software.

4.7. Statistical method used:

4.7.1. Sample size calculation:

Since the attempts into dysmorphic red cell analysis by automated urine analysers were new in the literature and both the machines were not being used

for dysmorphic red cell analysis at our department, a pilot study was done employing a population of 20 patients. Among the 2 machines Sysmex UX 2000 was only functional at that point of time and hence the pilot study was done utilising Sysmex UX 2000 automated analyser alone. It was found that Sysmex UX 2000 had a sensitivity and specificity of 75% and 58% respectively based on the pilot study. Further the sample size was calculated using nMaster 2.0 software. It was calculated that 200 patients has to be included in each category of glomerular and nonglomerular etiology (By phase contrast microscopy). Since the second automated urine analyser was not put to function at that time, we decided to extrapolate the study to a maximum of 800 patients which was obtained during the study period of 6 months.

4.7.2. Clinical Research Form:

The data obtained from each machine and the necessary clinical information obtained from the clinical workstation were entered into the clinical research form for each cases. (Form attached in the annexure)

4.7.3. Data entry and analysis:

Data entry and analysis was done with Epidata software. Statistical analyses were performed by SPSS Statistics 20.0 (Statistical Package for Social Sciences version 20.0) and Excel 2007 also. The sensitivity, specificity, positive and negative predictive value were calculated for each machines in comparison to phase contrast microscopy. 95% confidence interval was also estimated for each.

RESULTS AND ANALYSIS

1020 samples with microscopic hematuria were analysed for the study, but 220 samples were excluded due to presence of gross hematuria and absence of graphical representation by Sysmex UX 2000 automated urine analyser. Rest of the 800 samples were processed in both automated urine analyser and was further subjected to phase contrast analysis.

5.1. Age distribution:

The population varied from an age group of 2 to 92 years. Maximum number of samples were included from patients who were in the age group of 41-49 years.

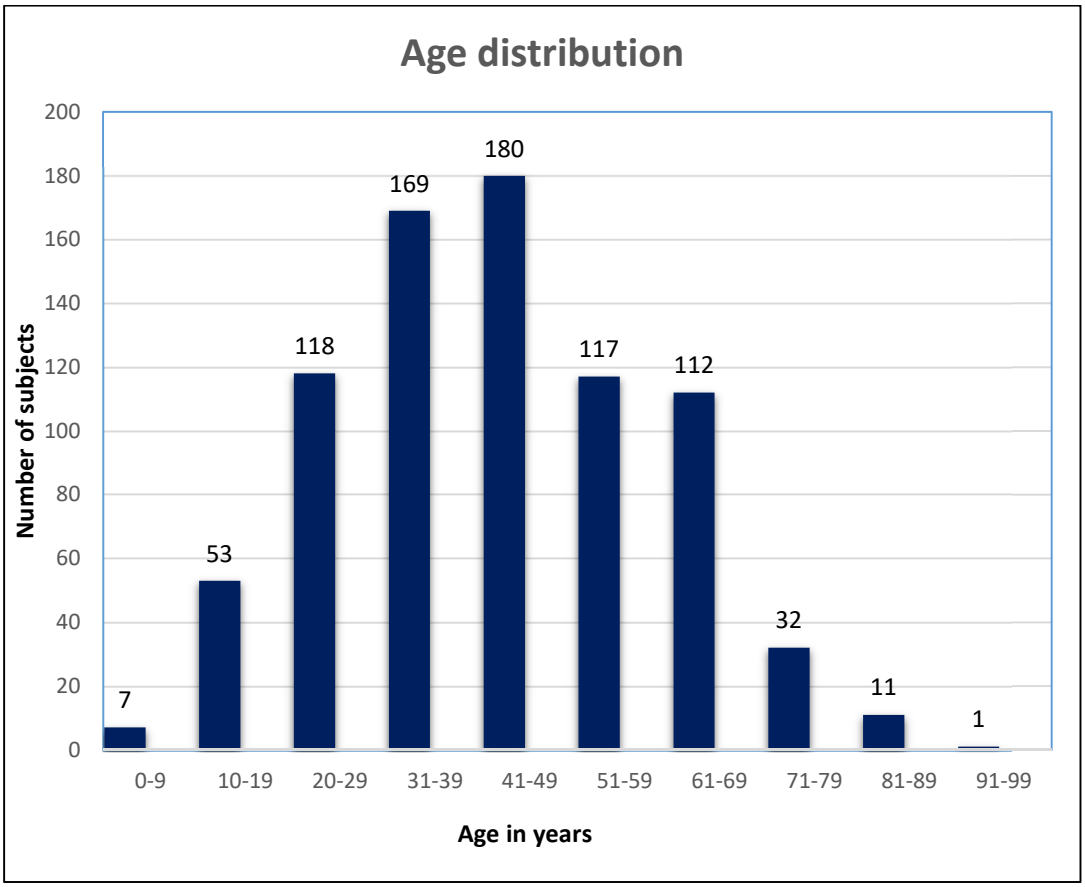


Figure 25: Graphical representation of age distribution

5.2. Gender distribution:

Of the 800 patients, 390 were males and 410 were females.

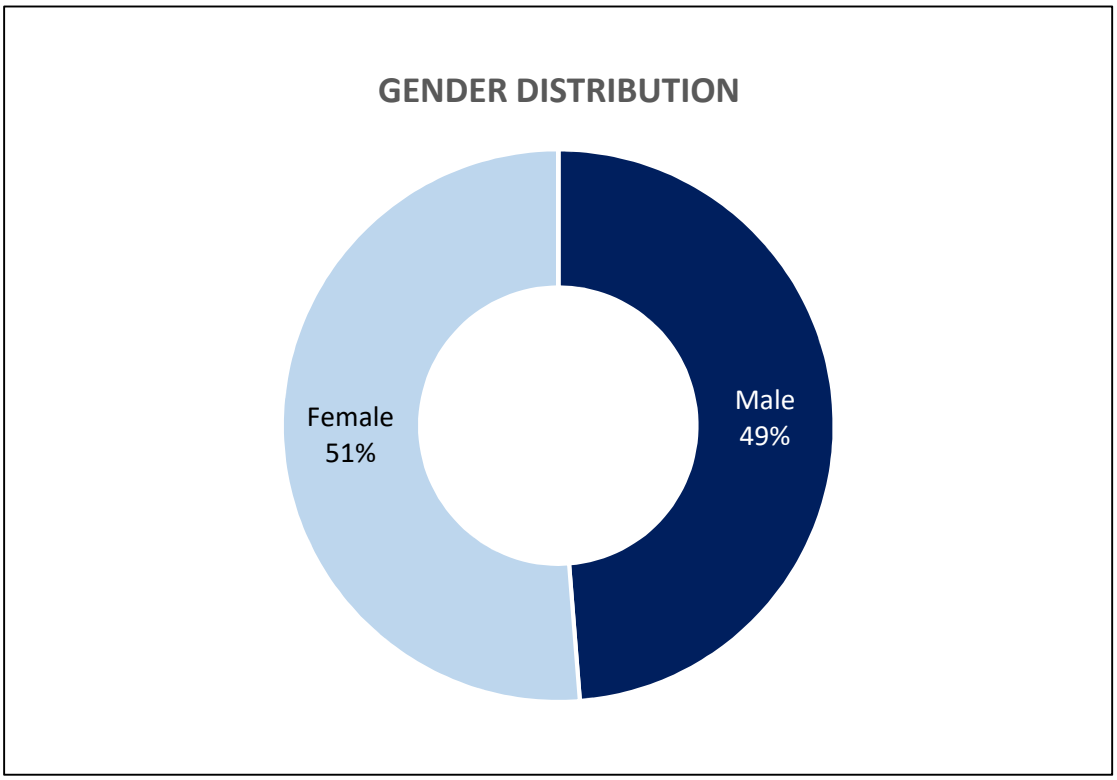


Figure 26: Graphical representation of gender distribution

5.3. Presence of proteinuria

PROTEINURIA	No. of Subjects	Percentage
Present	**616**	**77.0**
Absent	**184**	**23.0**
Total	**800**	**100**

Table 3 Degree of Proteinuria

5.4. Degree of hematuria:

The preliminary analysis for presence of hematuria detected 293 patients with 1+ hematuria, 393 with 2+ hematuria and 114 patients with 3+ hematuria.

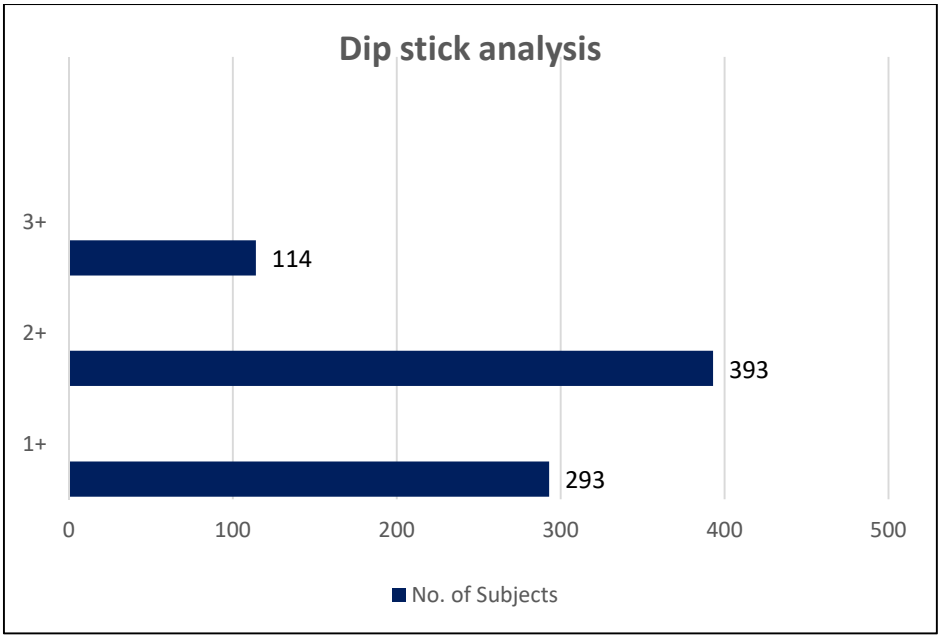


Figure 27: Graphical representation of dip stick results

5.5. Automated urine analyser results:

5.5.1. Analyser 1: Sysmex UX 2000:

800 samples were processed by Sysmex UX 2000 automated analyser based on the red cell distribution graphical representation. 534 samples were tagged as of glomerular etiology based on the red cell distribution to left as >80% of erythrocytes with ≤ 126 channels (ch) and 266 samples were tagged as nonglomerular aetiology based on the red cell distribution to right as >80% of erythrocytes with ≥ 84 channels. (55) The cases which were intermediate between these two with a difficulty in interpreting the results were excluded from the study. Also excluded were the cases without a definite graphical representation.

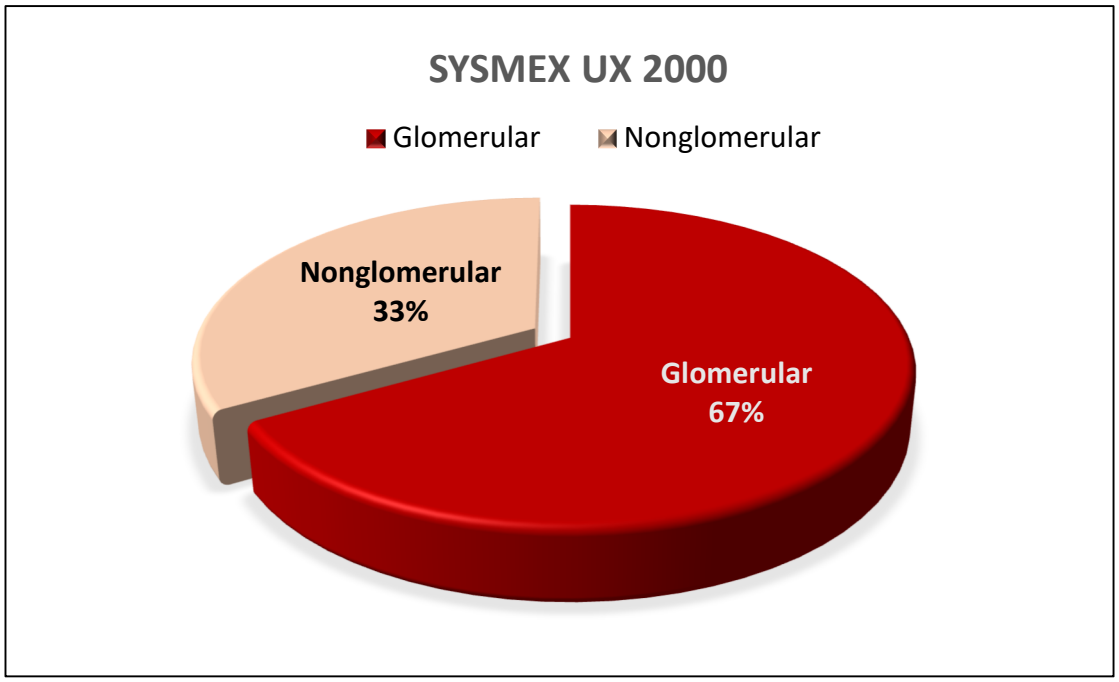


Figure 28: Sysmex UX 2000 result

5.5.2. Analyser 2: IRIS iQ 200:

Of the 800 samples run in the automated analyser IRIS iQ 200, none were automatically categorised into dysmorphic and non-dysmorphic even though the subcategory of Dysmorphic red cells existed in the panel. Further each sample were manually categorised based on the red cell morphology in comparison with the machine provided catalogue. The red cells with dysmorphic morphology were selected from the common pool of 'red blood cells' and 'unclassifiable'. Those were further moved into the pool of dysmorphic red cells manually. Once added into the pool, the machine automatically calculated the percentage of dysmorphism. The cut off of 25% was applied to categorise the cases further into glomerular and nonglomerular etiology. IRIS iQ 200 was successfully able to classify the cases into 57 with glomerular etiology as having ≥25% dysmorphism and 743 with nonglomerular etiology with <25% dysmorphic red cells.

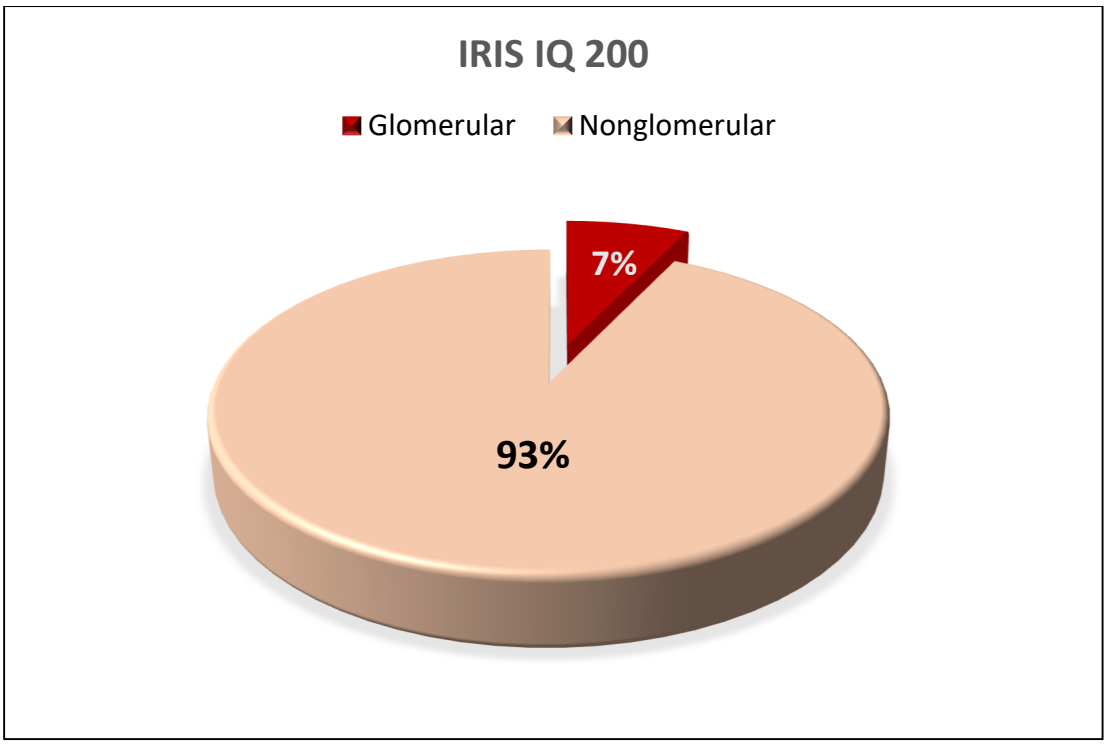


Figure 29: IRIS iQ 200 results

5.6. GOLD STANDARD: Phase contrast microscopy

The 800 samples were analysed for the presence of dysmorphism which was further categorised into glomerular and nonglomerular etiology based on the percentage of dysmorphic red cells in each case. 92 cases were found to be of glomerular etiology with ≥25% of dysmorphic red cells when observed by phase contrast microscopy and rest of the 708 cases were tagged as of nonglomerular etiology as the percentage of dysmorphic red cells was <25%.

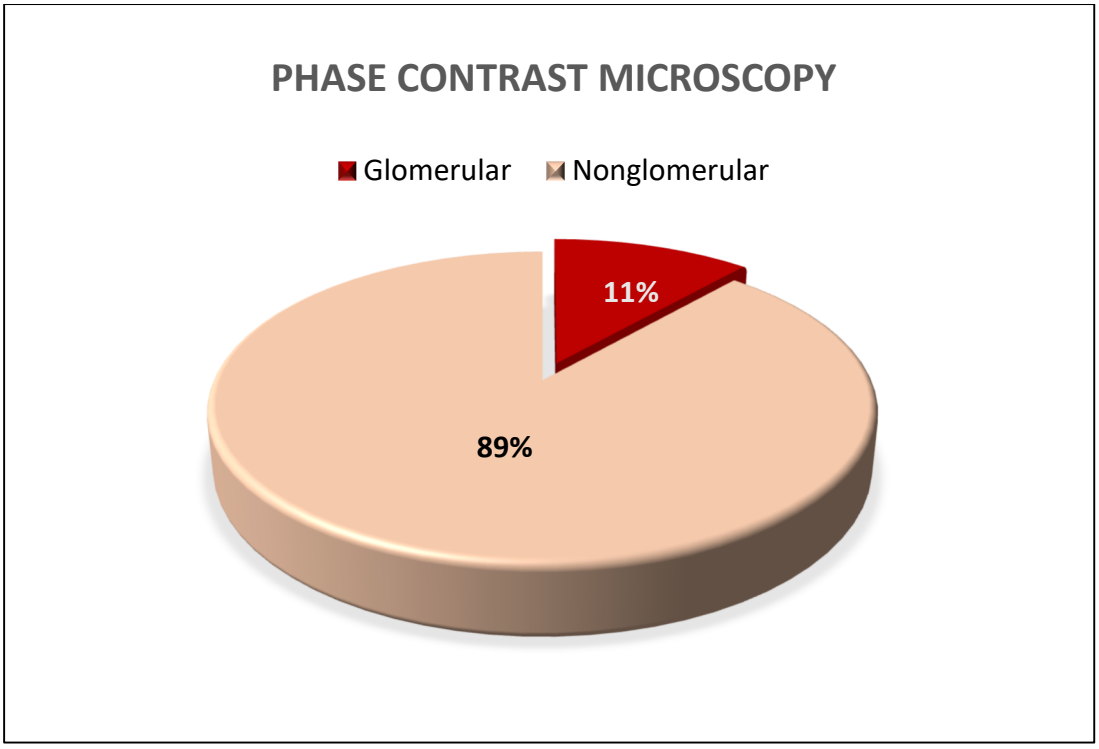


Figure 30: Phase contrast microscopy results

5.7. Comparative analysis:

The results obtained by the automated urine analysers Sysmex UX 2000 and IRIS iQ 200 were compared to the final diagnosis obtained by phase contrast microscopic analysis of the centrifuged urine sample. Each analysers were scrutinised for its diagnostic capability. The sensitivity, specificity, positive and negative predictive values were analysed based on the results. Attempts were also made to find the better diagnostic modality among the two in triaging cases with glomerular and nonglomerular pathology.

5.7.1. Analyser 1: Sysmex UX 2000

Sysmex UX 2000 vs Phase contrast Cross tabulation

		PHASE CONTRAST MICROSCOPY		TOTAL
		DYSMORPHIC	ISOMORPHIC	
SYSMEX UX 2000	DYSMORPHIC	87	447	534
	ISOMORPHIC	5	261	266
TOTAL COUNT		92	708	800

Table 4 Cross tabulation - Sysmex UX 2000 vs Phase contrast microscopy

Sensitivity: 94.6% (CI: 87.8-98.2)

Specificity: 36.9% (CI: 33.3-40.5)

Positive predictive value: 16.3% (CI: 13.3-19.7)

Negative predictive value: 98.1% (CI: 95.7-99.4)

(95% confidence interval within brackets)

5.7.2. Analyser 2: IRIS iQ 200:

IRIS iQ 200 vs Phase contrast Cross tabulation

		PHASE CONTRAST MICROSCOPY		TOTAL
		DYSMORPHIC	ISOMORPHIC	
IRIS iQ 200	DYSMORPHIC	36	21	57
	ISOMORPHIC	56	687	743
TOTAL COUNT		92	708	800

Table 5 Cross tabulation - IRIS iQ 200 vs Phase contrast microscopy

Sensitivity: 39.1% (CI: 29.1-49.9)

Specificity: 97% (CI: 95.5-98.2)

Positive predictive value: 63.2% (CI: 49.3-75.6)

Negative predictive value: 92.5% (CI: 90.3-94.3)

(95% confidence interval within brackets)

DISCUSSION

Hematuria being a clinical diagnostic challenge for proper categorisation of patients with nephrological and urologic illnesses methodically, there had been many attempts into the morphological analysis of red cells in urine. The mechanisation of diagnostic platform has widened the prospective for the urinalysis and has eased the manpower dependant units. There had been attempts to challenge and compare the diagnostic capability of automated urine analysers in the past. The present study comparing the diagnostic acumen of automated analysers Sysmex UX-2000 and IRIS iQ 200 in detecting dysmorphic red cell population was first in the line of research even though there were attempts to analyse the automated analysers in terms of cellular and formed elements in urine.

The present study included 1022 mid-stream catch samples with hematuria of which 800 samples were included for analysis. The study population ranged from 2 to 92 years. Most of the population fall within the age range of 41-49years.There was almost equal representation of male and female population which included 390 males and 410 females. In a similar study to analyse the automated modalities for urine analysis, Apeland et al had attempted to assess the ability of Sysmex UF-100 for differentiating glomerular and nonglomerular hematuria by including a population of the 112 subjects, of which 26 were female and 86 were male patients and they were further categorised into those with nephrological and urological diseases which were 57 and 55 respectively. The mean age for patients with nephrological and urological illness were 51.2+/-16.5 and 69.8+/-16.8 years respectively.(56) In a similar study done

by Jiang et al in 2011, had evaluated the performance of Sysmex UF-1000i by including a study population of 1631 samples, of which 930 were males and 701 were females.(57) Khejonnit et al in an attempt to set optimal criteria for microscopic review of urinalysis by automated urine analyser Sysmex UX-2000, had analysed 399 urine samples from routine work load. He also analysed another set of 599 samples to validate the optimised criteria for urine analysis.(59)

6.1. Degree of hematuria:

The study categorised the patients on the basis of degree of hematuria by automated dipstick analysis. Among the total 800 samples, 293 had 1+, 393 had 2+ and 114 had 3+ degree of hematuria. Among the population of 79 patients studied by Apeland et al 14 had 1+, 32 had 2+ and 31 patients had 3+ degree of hematuria. (56) The maximum population in both the studies were found to have 2+ degree of hematuria.

6.2. Presence of proteinuria:

In our study, 616 (77%) patients with microscopic hematuria had associated proteinuria while 184 (23%) samples were negative for proteinuria. Hyodo et al had described as association between microscopic hematuria and proteinuria amounting to 7.6%. (55)

6.3. Phase contrast microscopy:

Manual phase contrast microscopic analysis was employed as the gold standard for diagnosis. Of the 800 cases 708 were categorised into nonglomerular etiology and 92 into glomerular etiology based on the presence

and degree of dysmorphic red cell population present in centrifuged urine sample. The presence of ≥25% dysmorphic red cells was considered the cut off, above which cases were tagged as of glomerular etiology. Mohammed et al had attempted to localise the source of hematuria in 109 patients by employing phase contrast microscopy. The cut off for distinguishing glomerular and nonglomerular etiology was set as 20% above which the source was considered to be of glomerular in origin. They found that the phase contrast microscopy had a sensitivity of 90% and specificity of 100% for detecting glomerular source of bleeding. (24)

The present study did not attempt to gauge the diagnostic capacity of phase contrast microscopy as the standards were established in an institutional based study done in the year of 1995. The cut off value of 25% was found to maximize the overall performance of the test. Phase contrast microscopy was found to have a sensitivity, specificity, positive and negative predictive values of 89.13%, 98.33%, 99.39% and 74.68% for detecting glomerular hematuria. Hence the diagnosis by phase contrast microscopy was set as the gold standard with a calculated accuracy percentage of 91.40% based on the institution based studies. Performances of both the automated analysers were hence analysed in cmparison to the diagnosis obtained from phase contrast examination.

6.4. Sysmex UX-2000 automated analyser:

Our study had categorised 800 samples into glomerular and nonglomerular based on the histogram analysis applying Kitasatos' major criteria. Samples showing graphical representation of mixed population were not

included in the study. Accordingly the 800 samples were categorised into 534 samples with glomerular etiology and 266 with nonglomerular etiology by analysis of histogram obtained in Sysmex with the respective discrimination points. Among the 92 samples of glomerular etiology diagnosed by PCM, 87 were correctly diagnosed as glomerular by Sysmex while among the 708 nonglomerular cases, 261 were detected to be of nonglomerular etiology by Sysmex. Hence in the diagnostic challenge, Sysmex UX-2000 had sensitivity of 94.6% (CI: 87.8-98.2) while the specificity was only 36.9% (CI: 33.3-40.5). The positive and negative predictive value was 16.3% (CI: 13.3-19.7) and 98.1% (CI: 95.7-99.4) respectively for Sysmex UX-2000 in detecting microscopic hematuria of glomerular etiology. With the high degree of sensitivity, Sysmex UX 2000 can be employed as a better screening test to categorise patients with microscopic hematuria.

Hyodo et all had analysed a total of 98 subjects of which 31 were having glomerular pathology and 67 had nonglomerular pathology. In an attempt to obtain a set point for discriminating the glomerular and nonglomerular hematuria, they found that flow cytometry had a sensitivity and specificity of 90.3 and 92.5% respectively while phase contrast microscopy had a sensitivity and specificity of 83.3 and 93.3% respectively. They concluded that automated urine flow cytometer can be used as part of routine urine analysis and is a promising screening test in differentiating glomerular and nonglomerular hematuria. The author also put forth the advantage of flowmeter over the other

diagnostic modalities as it can process many samples within a short period of time and does not necessitate the need for much skill and knowledge. (55)

Apeland et al had attempted the categorization based on the Kitasato criteria, where they had also included the cases with mixed population based on the histogram analysis. In cases with ambiguous findings, minor criteria was employed to identify the source of bleeding which included the presence of increased number of small round cells with renal tubular morphology and pathological casts indicative of glomerular etiology and elevated levels of leukocytes, bacteria and yeasts indicative of nonglomerular etiology. Chi square tests were used for categorical differences and statistical analysis. In their study, Sysmex UF-100 had identified 29 out of 31 patients with nephrological disease and 40 out of 48 patients with urological disease. Their study showed that Sysmex UF-100 had a specificity and sensitivity of 94 and 83% in detecting nonglomerular bleeding with a positive and negative predictive value of 95% and 78% respectively. (56)

Jiang et al had included the diagnostic capacity of Sysmex UF-1000i in identifying dysmorphic red cell among the other parameters studied. The criteria used to identify the source of bleeding was >80% dysmorphic red cells for renal hematuria and >80% isomorphic red cells for post renal hematuria. Those samples with intermediate results were tagged as mixed hematuria based on microscopic analysis. The comparison was done based on the morphology flags obtained in Sysmex UF-1000i which were based on fixed algorithms. In the study 151 of 191 post renal (78%) cases and 162 of 207 renal (77%) cases were

correctly identified by the automated analyser. In 28 cases the machine failed to classify hematuria as the red cell counts were too low for analysis. (57)

Shayanfar et al in their attempt to do comparative analysis found that the samples which were flagged for dysmorphism could contain normal erythrocyte of smaller size. They also concluded that the Sysmex UF-100 had a high degree of deficit while analysing samples containing yeast, crystals and spermatocytes which tend to overlap the erythrocyte gate in scattergram. (71)

Even though Khejonnit et al had attempted to analyse the efficiency of Sysmex UX-2000, they did not attempt to identify the dysmorphic red cells. In spite of mentioning the dysmorphic red cells among the flagged elements in the optimised criteria there was no attempt to analyse the diagnostic capability, nor the chances of missing the same. (59)

6.5. IRIS iQ 200 automated analyser

The study had employed manual categorisation of red cells into dysmorphic pool and machine had automatically calculated the percentage of dysmorphism. The cut off was taken as the same as that of Phase contrast microscopic analysis being >25% of dysmorphism considered as of glomerular etiology. The categorisation of images were done by the principal investigator who was blinded about the microscopic report of each case. Of the 92 patients with glomerular etiology, 36 were detected by IRIS iQ200 while out of the 708 patients with nonglomerular etiology, IRIS could correctly pick up 687. Hence the machine could detect glomerular pathology with a sensitivity and specificity

of 39.1(CI: 29.1-49.9) and 97% (CI: 95.5-98.2) respectively. This automated analyser had a positive and negative predictive value of 63.2% (CI: 49.3-75.6) and 92.5 % (CI: 90.3-94.3).

Even though there had been attempts to analyse the multimodality performance status of IRIS iQ 200, the approach to dysmorphic red cell analysis was put forth in the year of 2008 by van den Broek et al. Apart from the stream of analysis for other parameters, 83 samples with special request for dysmorphic red cell analysis were subjected to analysis by microscopy and IRIS automated analyser. The study came with a finding that 12 out of 83 samples were correctly tagged as dysmorphic by both machine and microscope. They also found that the dysmorphic red cells were classified as either erythrocytes or unclassified particles.

Bowen et al in the attempt to analyse IRIS iQ 200 as a diagnostic tool for detecting dysmorphic red cells found that the machine was unable to automatically recognise and classify dysmorphic erythrocytes and the process is dependent on image reviewing by technicians. The automated analyser could produce adequate images of D1 and D2 cells with sufficient resolution and clarity, but the resolution was not adequate enough to identify D3 cells. (68)

In the comparative analysis done by Shayanfar et al they found that the red cell yield was low when the abnormal erythrocytes like ghost forms and dysmorphic red cells were present. Abnormally high counts were also noted in cases where yeast forms were misclassified as yeast. They suggested the use of

visual microscopy over the automated urine analysers in distinguishing dysmorphic red cells. (71)

CONCLUSION

To analyse the diagnostic accuracy of automated urine analysers in detecting dysmorphic red cells in urine a prospective study was done for a period of 6 months, employing a population of 800 samples. The population varied from 2 years to 92 years of age with an almost equal gender distribution. All the samples were processed in the two automated urine analysers, Sysmex UX-2000 and IRIS iQ 200 for the diagnostic yield of dysmorphic red cells. Histogram analysis by applying Kitasato criteria were used to classify red cell population in Sysmex automated analyser. In IRIS iQ 200 the auto particle recognition images were analysed by the investigator to categorise the morphology into dysmorphic and isomorphic red cells and the software provided a calculated percentage based on the proportion of each dysmorphic and isomorphic population. The final diagnosis by phase contrast microscopy was considered as the gold standard. At the completion of the study we reached at the following conclusions.

- Sysmex UX-2000 had sensitivity, specificity, positive and negative predictive value of 94.6, 36.9, 16.3 and 98.1% respectively.
- IRIS-iQ 200 had a sensitivity, specificity, positive and negative predictive value of 39.1, 97, 63.2 and 92.5% respectively.
- Sysmex UX-2000 had a high sensitivity in picking up the dysmorphic population this test can be recommended as a suitable screening test.
- IRIS iQ 200 can be employed to detect the isomorphic red cell population with a better precision and it was found to have a specificity of 97% in the study. Hence this test can be utilised as a better diagnostic test with high degree of specificity.

With a high negative predictive value, IRIS iQ 200 could categorise the cases with a high degree of precision when compared to Sysmex UX-2000. But since the IRIS iQ 200 is unable to automatically classify the red cells and auto validate them, the processing still warrants the need for a trained technical person for categorisation of machine generated red cell pictures. If the software is equipped with the automatic classification and validation system with a better clarity in the auto particle recognised images, the automated urine analyser IRIS iQ 200 can replace the phase contrast microscope in the long run as a better diagnostic test.

LIMITATIONS

- The study was conducted over a period of 6 months and the sample size was restricted due to the same.
- Many cases were not included in the study as the samples were not processed in both machines due to technical issues.
- Morphological alterations in treated cases with glomerular and nonglomerular etiology were not described in the literature and hence were not looked into in the present study.
- The images captured by IRIS iQ 200 were categorised based on the catalogue provided images. Few of the machine provided images were of poor resolution. Hence few of the images in the unclassified category were not further categorised.

BIBLIOGRAPHY

1. Echeverry G, Hortin GL, Rai AJ. Introduction to urinalysis: historical perspectives and clinical application. Methods Mol Biol Clifton NJ. 2010;641:1–12.

2. Carlson DA, Statland BE. Automated urinalysis. Clin Lab Med. 1988 Sep;8(3):449–61.

3. Ben-Ezra J, Bork L, McPherson RA. Evaluation of the Sysmex UF-100 automated urinalysis analyzer. Clin Chem. 1998 Jan;44(1):92–5.

4. Mayo S, Acevedo D, Quiñones-Torrelo C, Canós I, Sancho M. Clinical laboratory automated urinalysis: comparison among automated microscopy, flow cytometry, two test strips analyzers, and manual microscopic examination of the urine sediments. J Clin Lab Anal. 2008;22(4):262–70.

5. Matthew R. Pincus RAM. Henry's Clinical Diagnosis and Management by Laboratory Methods. 23rd ed. Elsevier Health Sciences; 2017. 28 p.

6. European Confederation of Laboratory Medicine. European urinalysis guidelines. Scand J Clin Lab Investig Suppl. 2000;231:1–86.

7. Armstrong JA. Urinalysis in Western culture: a brief history. Kidney Int. 2007 Mar;71(5):384–7.

8. Eknoyan G. Rufus of Ephesus and his "Diseases of the Kidneys." Nephron. 2002 Jul;91(3):383–90.

9. White WI. A new look at the role of urinalysis in the history of diagnostic medicine. Clin Chem. 1991 Jan;37(1):119–25.

10. Magiorkinis E, Diamantis A. The fascinating story of urine examination: From uroscopy to the era of microscopy and beyond. Diagn Cytopathol. 2015 Dec;43(12):1020–36.

11. Cameron JS. A history of urine microscopy. Clin Chem Lab Med. 2015 Nov;53 Suppl 2:s1453-1464.

12. Addis T. Glomerular nephritis Newyork. MacMillan 1948. :42.

13. Larcom RC, Carter GH. Erythrocytes in urinary sediment; identification and normal limits, with a note on the nature of granular casts. J Lab Clin Med. 1948 Jul;33(7):875–80.

14. Kirkpatrick WG. Hematuria. In: Walker HK, Hall WD, Hurst JW, editors. Clinical Methods: The History, Physical, and Laboratory Examinations [Internet]. 3rd ed. Boston: Butterworths; 1990 [cited 2017 Jul 31]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK294/

15. Alan J. Wein, MD, PhD (HON), FACS LRK MD, MBA. Campbell - Walsh Urology. 11th edition. (Chapter 9).

16. Davis R, Jones JS, Barocas DA, Castle EP, Lang EK, Leveillee RJ, et al. Diagnosis, evaluation and follow-up of asymptomatic microhematuria (AMH) in adults: AUA guideline. J Urol. 2012 Dec;188(6 Suppl):2473–81.

17. Robert W. SW. Manual of nephrology. 6th edition. Lippincott Williams & Wilkins; 2005. 118-120 p.

18. Buteau A, Seideman CA, Svatek RS, Youssef RF, Chakrabarti G, Reed G, et al. What is evaluation of hematuria by primary care physicians? Use of electronic medical records to assess practice patterns with intermediate follow-up. Urol Oncol. 2014 Feb;32(2):128–34.

19. Crop MJ, de Rijke YB, Verhagen PCMS, Cransberg K, Zietse R. Diagnostic value of urinary dysmorphic erythrocytes in clinical practice. Nephron Clin Pract. 2010;115(3):c203-212.

20. Whaley-Connell AT, Vassalotti JA, Collins AJ, Chen S-C, McCullough PA. National Kidney Foundation's Kidney Early Evaluation Program (KEEP) annual data report 2011: executive summary. Am J Kidney Dis Off J Natl Kidney Found. 2012 Mar;59(3 Suppl 2):S1-4.

21. Birch DF, Fairley KF. Haematuria: glomerular or non glomerular. Lancet 1979. (ii):845–6.

22. Fairley KF, Birch DF. Hematuria: a simple method for identifying glomerular bleeding. Kidney Int. 1982 Jan;21(1):105–8.

23. Dinda AK. Imagecytometry: a new tool for diagnosis of glomerular haematuria. Indian J Pathol Microbiol. 2001 Jan;44(1):13–6.

24. David G. Bostwick, MD, MBA LC MD. Urologic Surgical Pathology. Third edition. Copyright © 2014, 2006, 1998 by Saunders, an imprint of Elsevier Inc.; 346-349 p.

25. Fassett RG, Horgan BA, Mathew TH. Detection of glomerular bleeding by phase-contrast microscopy. Lancet Lond Engl. 1982 Jun 26;1(8287):1432–4.

26. Birch DF, Fairley KF, Whitworth JA, Forbes I, Fairley JK, Cheshire GR, et al. Urinary erythrocyte morphology in the diagnosis of glomerular hematuria. Clin Nephrol. 1983 Aug;20(2):78–84.

27. Roth S, Renner E, Rathert P. Microscopic hematuria: advances in identification of glomerular dysmorphic erythrocytes. J Urol. 1991 Sep;146(3):680–4.

28. Abdurrahman MB, Kambal AM, Kurbaan KM, Imambaccus MY, Chagla AH. Diagnostic value of phase contrast microscopy in haematuria. Trop Geogr Med. 1985 Jun;37(2):171–4.

29. Mohammad KS, Bdesha AS, Snell ME, Witherow RO, Coleman DV. Phase contrast microscopic examination of urinary erythrocytes to localise source of bleeding: an overlooked technique? J Clin Pathol. 1993 Jul;46(7):642–5.

30. Chang BS. Red cell morphology as a diagnostic aid in hematuria. JAMA. 1984 Oct 5;252(13):1747–9.

31. Venkat Raman G, Pead L, Lee HA, Maskell R. A blind controlled trial of phase-contrast microscopy by two observers for evaluating the source of haematuria. Nephron. 1986;44(4):304–8.

32. De Santo NG, Nuzzi F, Capodicasa G, Lama G, Caputo G, Rosati P, et al. Phase contrast microscopy of the urine sediment for the diagnosis of glomerular and nonglomerular bleeding-data in children and adults with normal creatinine clearance. Nephron. 1987;45(1):35–9.

33. Köhler H, Wandel E, Brunck B. Acanthocyturia--a characteristic marker for glomerular bleeding. Kidney Int. 1991 Jul;40(1):115–20.

34. Offringa M, Benbassat J. The value of urinary red cell shape in the diagnosis of glomerular and post-glomerular haematuria. A meta-analysis. Postgrad Med J. 1992 Aug;68(802):648–54.

35. Janssens PM, Kornaat N, Tieleman R, Monnens LA, Willems JL. Localizing the site of hematuria by immunocytochemical staining of erythrocytes in urine. Clin Chem. 1992 Feb;38(2):216–22.

36. Nagahama D, Yoshiko K, Watanabe M, Morita Y, Iwatani Y, Matsuo S. A useful new classification of dysmorphic urinary erythrocytes. Clin Exp Nephrol. 2005 Dec;9(4):304–9.

37. Tesser Poloni JA, Bosan IB, Garigali G, Fogazzi GB. Urinary red blood cells: not only glomerular or nonglomerular. Nephron Clin Pract. 2012;120(1):c36–41; discussion c41.

32. Chu-Su Y, Shukuya K, Yokoyama T, Lin W-C, Chiang C-K, Lin C-W. Enhancing the Detection of Dysmorphic Red Blood Cells and Renal Tubular Epithelial Cells with a Modified Urinalysis Protocol.2017 Jan 11 [cited 2017 Aug 16];7.

39. Schramek P, Moritsch A, Haschkowitz H, Binder BR, Maier M. In vitro generation of dysmorphic erythrocytes. Kidney Int. 1989 Jul;36(1):72–7.

40. Briner VA, Reinhart WH. In vitro production of “glomerular red cells”: role of pH and osmolality. Nephron. 1990;56(1):13–8.

41. Fassett RG, Horgan B, Gove D, Mathew TH. Scanning electron microscopy of glomerular and non glomerular red blood cells. Clin Nephrol. 1983 Jul;20(1):11–6.

42. Pillsworth TJ, Haver VM, Abrass CK, Delaney CJ. Differentiation of renal from non-renal hematuria by microscopic examination of erythrocytes in urine. Clin Chem. 1987 Oct;33(10):1791–5.

43. Kitamoto Y, Yide C, Tomita M, Sato T. The mechanism of glomerular dysmorphic red cell formation in the kidney. Tohoku J Exp Med. 1992 Jun;167(2):93–105.

44. Rath B, Turner C, Hartley B, Chantler C. What makes red cells dysmorphic in glomerular haematuria? Pediatr Nephrol Berl Ger. 1992 Sep;6(5):424–7.

45. Van Iseghem P, Hauglustaine D, Bollens W, Michielsen P. Urinary erythrocyte morphology in acute glomerulonephritis. Br Med J Clin Res Ed. 1983 Oct 22;287(6400):1183.

46. Thal SM, DeBellis CC, Iverson SA, Schumann GB. Comparison of dysmorphic erythrocytes with other urinary sediment parameters of renal bleeding. Am J Clin Pathol. 1986 Dec;86(6):784–7.

47. Susan King Strasinger, DA, MT(ASCP) MSDL BS, MT(ASCP)SH. Urinalysis and Body Fluids. Fifth Edition. Copyright © 2008 by F. A. Davis Company;

48. Nancy A. Brunzel, MS, MLS(ASCP), CM. Fundamentals of Urine & Body Fluid Analysis. Third edition. Saunders, an imprint of Elsevier Inc.;

49. Ahmad G, Segasothy M, Morad Z. Urinary erythrocyte morphology as a diagnostic aid in haematuria. Singapore Med J. 1993 Dec;34(6):486–8.

50. Sultana T, Sultana T, Rahman MQ, Rahman F, Islam MS, Ahmed AN. Value of dysmorphic red cells and G1 cells by phase contrast microscopy in the diagnosis of glomerular diseases. Mymensingh Med J MMJ. 2011 Jan;20(1):71–7.

51. Deindoerfer FH, Gangwer JR, Laird CW, Ringold RR. “The Yellow IRIS” urinalysis workstation--the first commercial application of “automated intelligent microscopy.” Clin Chem. 1985 Sep;31(9):1491–9.

52. Shichiri M, Oowada A, Nishio Y, Tomita K, Shiigai T. Use of autoanalyser to examine urinary-red-cell morphology in the diagnosis of glomerular haematuria. Lancet Lond Engl. 1986 Oct 4;2(8510):781–2.

53. Shichiri M, Hosoda K, Nishio Y, Ogura M, Suenaga M, Saito H, et al. Red-cell-volume distribution curves in diagnosis of glomerular and non-glomerular haematuria. Lancet Lond Engl. 1988 Apr 23;1(8591):908–11.

54. Henneberg R, Nascimento AJ do, Kussen G, Barreto FC, Hauser AB. Comparison between Manual Methods and Automated Analyzer iQ200® Iris Diagnostics): A Study for the Optimization of Urinalysis. Int J Lab Med Res. 2015 Nov 1;1(2).

55. Hyodo T, Kumano K, Sakai T. Differential diagnosis between glomerular and nonglomerular hematuria by automated urinary flow cytometer. Kitasato University Kidney Center criteria. Nephron. 1999;82(4):312–23.

56. Apeland T, Mestad O, Hetland Ø. Assessment of haematuria: automated urine flowmetry vs microscopy. Nephrol Dial Transplant. 2001 Aug 1;16(8):1615–9.

57. Jiang T, Chen P, Ouyang J, Zhang S, Cai D. Urine particles analysis: performance evaluation of Sysmex UF-1000i and comparison among urine flow cytometer, dipstick, and visual microscopic examination. Scand J Clin Lab Invest. 2011 Feb;71(1):30–7.

58. Koo KC, Lee KS, Choi AR, Rha KH, Hong SJ, Chung BH. Diagnostic impact of dysmorphic red blood cells on evaluating microscopic hematuria: the urologist's perspective. Int Urol Nephrol. 2016 Jul;48(7):1021–7.

59. Khejonnit V, Pratumvinit B, Reesukumal K, Meepanya S, Pattanavin C, Wongkrajang P. Optimal criteria for microscopic review of urinalysis following use of automated urine analyzer. Clin Chim Acta Int J Clin Chem. 2015 Jan 15;439:1–4.

60. Sánchez-Mora C, Acevedo D, Porres MA, Chaqués AM, Zapardiel J, Gallego-Cabrera A, et al. Comparison of automated devices UX-2000 and SediMAX/AutionMax for urine samples screening: A multicenter Spanish study. Clin Biochem. 2017 Aug;50(12):714–8.

61. Linko S, Kouri TT, Toivonen E, Ranta PH, Chapoulaud E, Lalla M. Analytical performance of the Iris iQ200 automated urine microscopy analyzer. Clin Chim Acta Int J Clin Chem. 2006 Oct;372(1–2):54–64.

62. IRIS iChem velocity Urine chemistry system; Operator's manual. 300–4449 English International Rev FC 9/2015 Operator's Manual ed. (Issue FC, 9/2015).

63. David T. Wah. Analytic Performance of the iQ200 Automated Urine Microscopy Analyzer and Comparison With Manual Counts Using Fuchs-Rosenthal Cell Chambers. Am J Clin Pathol 2005;123:290-296; 1309.

64. Pornvaree Lamchiagdhase KP Pitimon Lomsomboonb, Pimpawee Srisucharta, Pornsri Tantinitia, Nongnute Khan-u-rab, Boonsong Preechaborisutku. Urine sediment examination: A comparison between the manual method and the iQ200 automated urine microscopy analyzer. Clinica Chimica Acta 358 (2005) 167–174; 2004.

65. Lia Alves FB Jordi Camps* and Jorge Joven. Preliminary evaluation of the Iris IQ 200 automated urine analyser. Clin Chem Lab Med 2005;43(9):967–970; 2005.

66. Butch AW, Wises PK, Wah DT, Gornet TG, Fritsche HA. A multicenter evaluation of the Iris iQ200 automated urine microscopy analyzer body fluids module and comparison with hemacytometer cell counts. Am J Clin Pathol. 2008 Mar;129(3):445–50.

67. Van den Broek D, Keularts IMLW, Wielders JPM, Kraaijenhagen RJ. Benefits of the iQ200 automated urine microscopy analyser in routine urinalysis. Clin Chem Lab Med. 2008;46(11):1635–40.

68. Boven LA, Kemperman H, Demir AY. A comparative analysis of the Iris iQ200 with manual microscopy as a diagnostic tool for dysmorphic erythrocytes in urine. Clin Chem Lab Med. 2012 Apr;50(4):751–3.

69. Fatma Demet İnce HYE. The comparison of automated urine analyzers with manual microscopic examination for urinalysis automated urine analyzers and manual urinalysis. Pract Lab Med 5 2016. 2016 Mar 11;14–20.

70. Bakan E, Ozturk N, Baygutalp NK, Polat E, Akpinar K, Dorman E, et al. Comparison of Cobas 6500 and Iris IQ200 fully-automated urine analyzers to manual urine microscopy. Biochem Medica. 2016 Oct 15;26(3):365–75.

71. Shayanfar N, Tobler U, von Eckardstein A, Bestmann L. Automated urinalysis: first experiences and a comparison between the Iris iQ200 urine microscopy system, the Sysmex UF-100 flow cytometer and manual microscopic particle counting. Clin Chem Lab Med. 2007;45(9):1251–6.

ANNEXURES

10.1. Institutional review board approval letter:

OFFICE OF RESEARCH
INSTITUTIONAL REVIEW BOARD (IRB)
CHRISTIAN MEDICAL COLLEGE, VELLORE, INDIA

Dr. B.J. Prashantham, M.A., M.A., Dr. Min (Clinical)
Director, Christian Counseling Center,
Chairperson, Ethics Committee.

Dr. Alfred Job Daniel, D Ortho MS Ortho DNB Ortho.
Chairperson, Research Committee & Principal

Dr. Biju George, MBBS., MD., DM
Deputy Chairperson,
Secretary, Ethics Committee, IRB
Additional Vice-Principal (Research)

June 07, 2016

Dr. Anju Mohan,
PG Registrar,
Department of General Pathology,
Christian Medical College,
Vellore 632 004.

Sub: **Fluid Research Funding: New Proposal**
Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analyzers Sysmex UX - 2000 and IRIS IQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria.
Anju Mohan (Employment Number: 21210), PG Registrar, General Pathology, Dr. Sukesh Chandran Nair , Employment Number: 13758, Transfusion Medicine and Immunohematology, Dr. Joy J Mammen , Employment number: 14379, Transfusion Medicine and Immunohematology, Dr. Santhosh Varughese , Employment number: 28219, Nephrology, Dr. Anna T Valson, Employment number: 31956, Nephrology, Ms. Tunny Sebastian, (Employment number: 32291,), Biostatistics.

Ref: IRB Min No: 9909 [DIAGNO] dated 05.02.2016

Dear Dr. Anju Mohan,
The Institutional Review Board (Blue, Research and Ethics Committee) of the Christian Medical College, Vellore, reviewed and discussed your project titled "Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analyzers Sysmex UX - 2000 and IRIS IQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria" on February 05th 2016.

The Committee reviewed the following documents:

1. IRB Application format
2. Information sheet
3. Proforma
4. Cvs of Drs. Anju Mohan, Sukesh Chandran Nair, Joy J Mammen, Santhosh Varughese , Ms. Tunny Sebastian
5. No.of documents 1 – 4

The following Institutional Review Board (Blue, Research & Ethics Committee) members were present at the meeting held on February 05th 2016 in the CREST/SACN Conference Room, Christian Medical College, Bagayam, Vellore 632002.

Ethics Committee Blue, Office of Research, 1st Floor, Carman Block, Christian Medical College, Vellore, Tamil Nadu 632 002
Tel: 0416 – 2284294, 2284202 Fax: 0416 – 2262788, 2284481 E-mail: research@cmcvellore.ac.in

Dr. B.J. Prashantham, M.A., M.A., Dr. Min (Clinical)
Director, Christian Counseling Center,
Chairperson, Ethics Committee.

Dr. Alfred Job Daniel, D Ortho MS Ortho DNB Ortho.
Chairperson, Research Committee & Principal

Dr. Biju George, MBBS., MD., DM
Deputy Chairperson,
Secretary, Ethics Committee, IRB
Additional Vice-Principal (Research)

Mrs. Emily Daniel	MSc Nursing	Professor, Medical Surgical Nursing, CMC, Vellore	Internal, Nurse
Dr. Vivek Mathew	MD (Gen. Med.) DM (Neuro) Dip. NB (Neuro)	Professor, Neurology, CMC, Vellore	Internal, Clinician
Mr. C. Sampath	BSc, BL	Advocate, Vellore	External, Legal Expert
Dr. Inian Samarasam	MS, FRCS, FRACS	Professor, Surgery, CMC, Vellore	Internal, Clinician

We approve the project to be conducted as presented.

Kindly provide the total number of patients enrolled in your study and the total number of withdrawals for the study entitled: "Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analyzers Sysmex UX - 2000 and IRIS IQ - 200 with manual phase contrast microscopy in cases of microscopic hematuria" on a monthly basis. Please send copies of this to the Research Office (research@cmcvellore.ac.in)

Fluid Grant Allocation:

A sum of 50,000/- INR (Rupees Fifty thousand Only) will be granted for 6 months.

Yours sincerely

Dr. Biju George
Secretary (Ethics Committee)
Institutional Review Board

Dr. BIJU GEORGE
MBBS., MD., DM.
SECRETARY - (ETHICS COMMITTEE)
Institutional Review Board,
Christian Medical College, Vellore - 632 002.

IRB Min No: 9909 [DIAGNO] dated 05.02.2016

Ethics Committee Blue, Office of Research, 1st Floor, Carman Block, Christian Medical College, Vellore, Tamil Nadu 632 002
Tel: 0416 – 2284294, 2284202 Fax: 0416 – 2262788, 2284481 E-mail: research@cmcvellore.ac.in

10.2. Clinical research form:

1

Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analyzers Sysmex UX - 2000 and IRIS IQ - 200 with manual phase contrast microsopy in cases of microscopic hematuria.

Sl No: ☐ Date: ☐

CLINICAL RESEARCH FORM

Name: Hospital No: ☐

Age: ☐ Clinical path No: ☐

Sex: M ☐ F ☐ Histopath Biopsy No: ☐

Socio economic status: (if applicable)

Presenting complaints:

Duration of illness:

Co-morbidities if any:

Smoker: Yes/ No.

Alcoholic: Yes/ No.

History of trauma/ coagulopathy/ radiation/ instrumentation:

Gross presence of blood in urine:

Are you a renal transplant donor:

If yes any co-morbidities:

Clinical diagnosis: ☐

Comparing the diagnostic accuracy of detecting dysmorphic RBCs in automated urine analyzers Sysmex UX - 2000 and IRIS IQ - 200 with manual phase contrast microsopy in cases of microscopic hematuria.

CLINICAL RESEARCH FORM

Step 1 : Dip stick test: Hematuria :

Step 2 : Sysmex 2000 analyser:

Step 3 : IRIS iQ 200 analyser :

Step 4: Phase contrast microscopy:

DATA TABULATION

Sl. No	Name	Dipstick	Sysmex 2000	IRIS iQ 200	Phase contrast microscopy	% of Dysmorphic RBCs

Step 5: Final histopathological Diagnosis:

10.3. Thesis data entry sheet:

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
1	38	Male	657771G	1624444062	3+	Absent	Glomerular	18	Nonglomerula	80	Glomerular
2	45	Female	544738K	1624544063	1+	Absent	Glomerular	48	Glomerular	62	Glomerular
3	12	Male	650013G	1624544235	2+	Present	Nonglomerul	9	Nonglomerula	0	Nonglomerula
4	45	Female	408482B	1624544088	1+	Absent	Glomerular	36	Glomerular	30	Glomerular
5	23	Female	857099F	1624544128	2+	Present	Glomerular	16	Nonglomerula	0	Nonglomerula
6	24	Male	961987F	1624544030	2+	Present	Nonglomerul	5	Nonglomerula	2	Nonglomerula
7	74	Male	490951C	1624544152	2+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
8	65	Female	698772A	1624544097	1+	Present	Glomerular	3	Nonglomerula	17	Nonglomerula
9	30	Female	106601G	1624544067	2+	Absent	Glomerular	23	Nonglomerula	35	Glomerular
10	69	Male	242082C	1624544099	3+	Absent	Glomerular	50	Glomerular	9	Nonglomerula
11	23	Female	141133B	1624544217	2+	Present	Nonglomerul	15	Nonglomerula	2	Nonglomerula
12	33	Female	676926G	1624544303	2+	Present	Glomerular	6	Nonglomerula	24	Nonglomerula
13	62	Female	229835C	1624544289	1+	Present	Glomerular	13	Nonglomerula	0	Nonglomerula
14	31	Female	674001G	1624544342	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
15	46	Male	609764G	1624544291	1+	Absent	Glomerular	24	Nonglomerula	100	Glomerular
16	64	Female	145304D	1624544068	2+	Present	Glomerular	7	Nonglomerula	0	Nonglomerula
17	64	Female	380174B	1624544105	2+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
18	23	Female	672941G	1624644033	1+	Present	Glomerular	5	Nonglomerula	40	Glomerular
19	33	Female	483223F	1624644068	3+	Present	Nonglomerul	19	Nonglomerula	30	Glomerular
20	72	Male	923228B	1624644046	1+	Present	Glomerular	11	Nonglomerula	0	Nonglomerula
21	60	Male	660594G	1624644034	2+	Present	Glomerular	18	Nonglomerula	0	Nonglomerula
22	52	Male	554522B	1624644123	3+	Present	Glomerular	24	Nonglomerula	68	Glomerular
23	35	Male	523556G	1624644137	3+	Present	Glomerular	7	Nonglomerula	0	Nonglomerula
24	31	Male	731984C	1624644279	2+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
25	49	Female	674914G	1624644219	1+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
26	52	Female	066161B	1624644258	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
27	37	Female	665916G	1624644333	2+	Present	Glomerular	5	Nonglomerula	100	Glomerular
28	66	Male	912284	1624744025	3+	Present	Glomerular	9	Nonglomerula	60	Glomerular
29	54	Female	667800G	1624744084	2+	Present	Glomerular	15	Nonglomerula	60	Glomerular
30	24	Male	670060G	1624744034	3+	Present	Glomerular	32	Glomerular	80	Glomerular
31	33	Female	775814F	1624744241	3+	Present	Glomerular	47	Glomerular	90	Glomerular
32	24	Male	075410G	1624744208	1+	Present	Glomerular	54	Glomerular	46	Glomerular
33	55	Female	743057F	1624744168	1+	Present	Glomerular	38	Glomerular	23	Nonglomerula
34	66	Male	679872G	1624744170	2+	Present	Glomerular	29	Glomerular	37	Glomerular
35	29	Male	679328G	1624744198	1+	Present	Glomerular	11	Nonglomerula	42	Glomerular
36	40	Male	969676C	1624744223	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
37	62	Male	511453G	1624744143	2+	Present	Nonglomerul	15	Nonglomerula	0	Nonglomerula
38	63	Male	679665G	1624744147	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
39	39	Male	199495B	1624744144	1+	Present	Glomerular	22	Nonglomerula	70	Glomerular
40	40	Male	680820G	1624744081	3+	Present	Glomerular	27	Glomerular	0	Nonglomerula
41	49	Female	658787G	1624744026	2+	Present	Glomerular	29	Glomerular	0	Nonglomerula
42	49	Female	692106G	1627044114	3+	Present	Glomerular	33	Glomerular	65	Glomerular
43	35	Female	687219G	1626844192	1+	Present	Glomerular	10	Nonglomerula	15	Nonglomerula
44	52	Female	166142G	1627044111	1+	Absent	Glomerular	16	Nonglomerula	27	Glomerular
45	32	Female	005478G	1627044192	2+	Present	Glomerular	67	Glomerular	55	Glomerular
46	39	Male	521707F	1627044102	1+	Present	Glomerular	13	Nonglomerula	18	Nonglomerula
47	26	Female	331522F	1627244040	2+	Present	Nonglomerul	13	Nonglomerula	20	Nonglomerula
48	70	Female	526261G	1627344089	3+	Present	Glomerular	7	Nonglomerula	22	Nonglomerula
49	47	Female	011386G	1627244112	2+	Present	Nonglomerul	7	Nonglomerula	17	Nonglomerula
50	69	Male	526607G	1627244114	3+	Present	Nonglomerul	1	Nonglomerula	3	Nonglomerula
51	44	Male	698213G	1627244075	2+	Present	Glomerular	14	Nonglomerula	39	Glomerular
52	64	Male	527088G	1627244086	3+	Present	Glomerular	8	Nonglomerula	40	Glomerular
53	62	Male	526604G	1627244100	2+	Present	Glomerular	8	Nonglomerula	26	Glomerular
54	27	Male	188410G	1627244117	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
55	27	Female	527055G	1627344085	2+	Present	Glomerular	34	Glomerular	65	Glomerular
56	78	Male	320398C	1627344080	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
57	25	Male	125904C	1627344081	3+	Present	Nonglomerul	1	Nonglomerula	1	Nonglomerula
58	44	Female	851357B	1627344071	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
59	32	Female	877435D	1627344061	2+	Absent	Glomerular	53	Glomerular	34	Glomerular
60	32	Female	398581G	1624344058	2+	Present	Glomerular	21	Nonglomerula	55	Glomerular
61	80	Male	559860	1627344067	1+	Present	Nonglomerul	4	Nonglomerula	0	Nonglomerula
62	50	Male	746734F	1627344050	1+	Present	Glomerular	42	Glomerular	36	Glomerular
63	67	Female	948331C	1627344036	2+	Present	Glomerular	19	Nonglomerula	18	Nonglomerula
64	55	Male	699336G	1627444068	3+	Present	Glomerular	5	Nonglomerula	90	Glomerular
65	44	Male	700458G	1627444060	1+	Present	Glomerular	27	Glomerular	22	Nonglomerula
66	49	Male	680197G	1627444080	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
67	30	Female	980151F	1627444085	1+	Present	Glomerular	55	Glomerular	68	Glomerular
68	30	Female	757700D	1627444083	1+	Present	Glomerular	32	Glomerular	36	Glomerular
69	44	Female	700726G	1627444088	2+	Present	Nonglomerul	45	Glomerular	0	Nonglomerula
70	35	Male	393241F	1627444073	2+	Present	Glomerular	4	Nonglomerula	44	Glomerular
71	46	Female	838509C	1627444091	3+	Present	Nonglomerul	1	Nonglomerula	15	Nonglomerula
72	27	Female	527055G	1627444146	2+	Present	Glomerular	23	Nonglomerula	48	Glomerular
73	60	Male	612903G	1627744210	2+	Present	Glomerular	32	Glomerular	65	Glomerular
74	66	Male	535950C	1627744163	2+	Present	Glomerular	2	Nonglomerula	8	Nonglomerula
75	28	Female	939909F	1627744144	3+	Present	Glomerular	43	Glomerular	75	Glomerular
76	43	Male	158289G	1627744251	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
77	39	Male	703454G	1627744357	2+	Present	Nonglomerul	0	Nonglomerula	20	Nonglomerula
78	66	Male	783481F	1627744148	1+	Absent	Nonglomerul	3	Nonglomerula	1	Nonglomerula
79	23	Male	703393G	1627894102	2+	Present	Glomerular	30	Glomerular	75	Glomerular
80	39	Female	047180D	1627844277	1+	Present	Glomerular	2	Nonglomerula	8	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
81	68	Male	195458F	1627844228	1+	Present	Glomerular	9	Nonglomerula	2	Nonglomerula
82	75	Male	656563G	1627844146	1+	Absent	Nonglomerul	7	Nonglomerula	0	Nonglomerula
83	40	Female	665939G	1627844137	3+	Present	Nonglomerul	0	Nonglomerula	3	Nonglomerula
84	5	Male	703651G	1627944104	1+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
85	29	Female	629721F	1627944060	2+	Present	Glomerular	31	Glomerular	55	Glomerular
86	53	Male	560606C	1627944021	3+	Present	Nonglomerul	9	Nonglomerula	45	Glomerular
87	36	Female	929679F	1627944070	3+	Absent	Nonglomerul	4	Nonglomerula	0	Nonglomerula
88	62	Male	703413G	1627944079	3+	Present	Nonglomerul	10	Nonglomerula	5	Nonglomerula
89	45	Female	704639G	1627944077	2+	Present	Glomerular	40	Glomerular	58	Glomerular
90	66	Male	659176G	1627944118	1+	Absent	Nonglomerul	2	Nonglomerula	0	Nonglomerula
91	18	Female	286146G	1627944436	2+	Present	Nonglomerul	0	Nonglomerula	5	Nonglomerula
92	58	Male	295108F	1627944350	2+	Present	Glomerular	1	Nonglomerula	5	Nonglomerula
93	41	Female	668793G	1627944389	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
94	43	Female	683571G	1627944418	2+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
95	44	Female	713686A	1627944393	2+	Present	Nonglomerul	53	Glomerular	35	Glomerular
96	20	Male	527633G	1627944150	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
97	36	Female	284368F	1627944398	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
98	29	Female	674839G	1627944323	2+	Present	Glomerular	59	Glomerular	0	Nonglomerula
99	70	Female	526261G	1627344089	3+	Present	Glomerular	6	Nonglomerula	25	Nonglomerula
100	35	Female	691220G	1627944053	3+	Present	Glomerular	8	Nonglomerula	65	Glomerular
101	75	Male	694843G	1628044218	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
102	23	Female	703146G	1628044164	2+	Present	Glomerular	46	Glomerular	11	Nonglomerula
103	30	Male	527433G	1628044028	1+	Present	Glomerular	23	Nonglomerula	0	Nonglomerula
104	39	Male	850255	1628044178	2+	Present	Glomerular	22	Nonglomerula	20	Nonglomerula
105	30	Female	701724G	1628044168	2+	Present	Nonglomerul	6	Nonglomerula	0	Nonglomerula
106	63	Female	526891G	1628044145	2+	Absent	Glomerular	53	Glomerular	45	Glomerular
107	63	Female	122053D	1628044197	1+	Present	Nonglomerul	19	Nonglomerula	0	Nonglomerula
108	92	Male	053253A	1628044107	1+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
109	71	Male	698645G	1628044103	2+	Present	Glomerular	30	Glomerular	55	Glomerular
110	43	Male	698188G	1628044279	1+	Present	Glomerular	12	Nonglomerula	3	Nonglomerula
111	35	Male	703703G	1628044192	1+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
112	28	Female	727453D	1628044276	2+	Present	Glomerular	36	Glomerular	47	Glomerular
113	64	Male	527088G	1627744047	3+	Present	Glomerular	6	Nonglomerula	25	Nonglomerula
114	43	Male	521057F	1627844093	2+	Absent	Glomerular	0	Nonglomerula	35	Glomerular
115	40	Male	693775G	1627844135	2+	Present	Glomerular	7	Nonglomerula	45	Glomerular
116	61	Male	448379G	1627544170	2+	Present	Nonglomerul	8	Nonglomerula	20	Nonglomerula
117	60	Female	527624G	1628144062	1+	Absent	Glomerular	13	Nonglomerula	22	Nonglomerula
118	38	Male	740796C	1628144131	2+	Present	Glomerular	5	Nonglomerula	5	Nonglomerula
119	58	Male	707287G	1628144143	1+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
120	24	Female	706470G	1628144127	1+	Present	Nonglomerul	8	Nonglomerula	1	Nonglomerula
121	75	Male	603338B	1628144056	2+	Present	Glomerular	6	Nonglomerula	16	Nonglomerula
122	38	Male	430878D	1628144054	2+	Present	Nonglomerul	10	Nonglomerula	5	Nonglomerula
123	53	Female	703949G	1628144070	1+	Present	Glomerular	14	Nonglomerula	25	Nonglomerula
124	37	Female	514253D	1628144246	1+	Present	Glomerular	12	Nonglomerula	0	Nonglomerula
125	51	Female	873300B	1628144235	1+	Absent	Glomerular	12	Nonglomerula	22	Nonglomerula
126	24	Female	702657A	1628144237	2+	Present	Nonglomerul	11	Nonglomerula	0	Nonglomerula
127	68	Male	699132G	1628144332	1+	Absent	Glomerular	18	Nonglomerula	2	Nonglomerula
128	29	Female	471686G	1628144254	3+	Present	Glomerular	8	Nonglomerula	26	Glomerular
129	30	Male	379811D	1628144171	3+	Present	Glomerular	38	Glomerular	30	Glomerular
130	14	Female	704565G	1628244058	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
131	47	Male	342629F	1628244043	2+	Present	Glomerular	29	Glomerular	50	Glomerular
132	45	Female	657607G	1628244056	2+	Absent	Glomerular	14	Nonglomerula	4	Nonglomerula
133	38	Male	703728G	1628244103	1+	Present	Glomerular	7	Nonglomerula	5	Nonglomerula
134	60	Female	527968G	1628244150	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
135	52	Male	697512G	1628244086	1+	Present	Glomerular	30	Glomerular	45	Glomerular
136	53	Male	635650G	1628244124	1+	Absent	Glomerular	11	Nonglomerula	20	Nonglomerula
137	58	Female	839306D	1628244127	2+	Present	Glomerular	23	Nonglomerula	15	Nonglomerula
138	51	Male	704523G	1628244051	3+	Present	Glomerular	11	Nonglomerula	75	Glomerular
139	55	Male	706218G	1628244073	2+	Present	Glomerular	12	Nonglomerula	0	Nonglomerula
140	34	Male	178828G	1628244155	2+	Present	Glomerular	4	Nonglomerula	10	Nonglomerula
141	65	Male	353038C	1628244044	1+	Present	Glomerular	1	Nonglomerula	15	Nonglomerula
142	19	Male	527894G	1628244254	2+	Present	Glomerular	3	Nonglomerula	1	Nonglomerula
143	49	Female	702889G	1628244194	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
144	25	Female	527927G	1628244250	2+	Present	Glomerular	12	Nonglomerula	2	Nonglomerula
145	37	Female	527749G	1628244264	2+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
146	44	Female	787807F	1628244281	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
147	9	Male	650420G	1628244166	2+	Present	Glomerular	26	Glomerular	45	Glomerular
148	58	Male	707148G	1628244157	2+	Present	Glomerular	25	Nonglomerula	0	Nonglomerula
149	31	Female	797122D	1628244165	2+	Present	Glomerular	59	Glomerular	44	Glomerular
150	25	Male	963912F	1628244229	2+	Absent	Nonglomerul	6	Nonglomerula	0	Nonglomerula
151	35	Male	708646g	1628444124	2+	Present	Glomerular	17	Nonglomerula	20	Nonglomerula
152	27	Female	530165G	1628444101	2+	Present	Glomerular	18	Nonglomerula	65	Glomerular
153	45	Female	678980G	1628444138	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
154	33	Female	241863C	1628444127	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
155	17	Female	708475G	1628444073	2+	Present	Nonglomerul	11	Nonglomerula	0	Nonglomerula
156	39	Female	675347D	1628444050	3+	Present	Glomerular	5	Nonglomerula	10	Nonglomerula
157	47	Female	526274G	1628444113	2+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
158	39	Female	340989G	1628444182	2+	Present	Nonglomerul	16	Nonglomerula	5	Nonglomerula
159	15	Female	429690F	1628444142	1+	Present	Glomerular	8	Nonglomerula	18	Nonglomerula
160	18	Female	286146G	1628444140	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
161	45	Female	149716C	1628444114	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
162	23	Female	527904G	1628444190	2+	Present	Glomerular	4	Nonglomerula	5	Nonglomerula
163	44	Male	706266G	1628444415	2+	Present	Glomerular	1	Nonglomerula	5	Nonglomerula
164	45	Female	706098G	1628444348	1+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
165	51	Female	706099G	1628444302	2+	Absent	Glomerular	11	Nonglomerula	2	Nonglomerula
166	52	Female	530185G	1628444255	1+	Present	Glomerular	7	Nonglomerula	5	Nonglomerula
167	42	Female	390073G	1628444186	2+	Absent	Nonglomerul	6	Nonglomerula	3	Nonglomerula
168	40	Female	709718G	1628444261	2+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
169	39	Female	199836C	1628544130	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
170	45	Female	670925D	1628544078	2+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
171	54	Female	094618D	1628544056	1+	Present	Glomerular	21	Nonglomerula	20	Nonglomerula
172	27	Female	530104G	1628544081	3+	Absent	Nonglomerul	4	Nonglomerula	0	Nonglomerula
173	42	Female	530093G	1628544018	3+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
174	43	Female	431958G	1628544203	1+	Absent	Glomerular	4	Nonglomerula	12	Nonglomerula
175	37	Female	345078G	1628544197	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
176	70	Female	530278G	1628544228	3+	Present	Nonglomerul	6	Nonglomerula	0	Nonglomerula
177	53	Male	530280G	1628544230	1+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
178	36	Female	652193G	1628544211	1+	Absent	Nonglomerul	6	Nonglomerula	0	Nonglomerula
179	44	Male	634988C	1628644087	2+	Present	Nonglomerul	5	Nonglomerula	0	Nonglomerula
180	39	Female	682140D	1628644086	2+	Absent	Glomerular	33	Glomerular	65	Glomerular
181	15	Male	452321F	1628644073	2+	Present	Glomerular	17	Nonglomerula	15	Nonglomerula
182	62	Male	704674G	1628644072	1+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
183	55	Male	707799G	1628644063	1+	Present	Glomerular	22	Nonglomerula	15	Nonglomerula
184	52	Female	423952F	1628644056	1+	Absent	Glomerular	4	Nonglomerula	8	Nonglomerula
185	32	Female	088342C	1628644045	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
186	43	Female	329096D	1628644043	2+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
187	52	Female	530185G	1628644035	3+	Present	Glomerular	20	Nonglomerula	5	Nonglomerula
188	41	Female	526615G	1628644027	2+	Absent	Glomerular	10	Nonglomerula	5	Nonglomerula
189	25	Female	422034G	1628744106	1+	Present	Glomerular	43	Glomerular	25	Nonglomerula
190	48	Female	530438G	1628744104	2+	Present	Nonglomerul	4	Nonglomerula	0	Nonglomerula
191	62	Male	240621G	1628744120	2+	Present	Glomerular	39	Glomerular	45	Glomerular
192	60	Male	680342D	1628744310	2+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
193	34	Female	709536G	1628744330	1+	Present	Glomerular	2	Nonglomerula	5	Nonglomerula
194	54	Female	677974G	1628744135	1+	Absent	Glomerular	41	Glomerular	551	Glomerular
195	48	Female	833397C	1628744248	3+	Present	Glomerular	8	Nonglomerula	20	Nonglomerula
196	45	Male	371901G	1628844180	1+	Present	Glomerular	6	Nonglomerula	55	Glomerular
197	15	Male	708494G	1628844165	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
198	64	Female	836884C	1628844241	2+	Present	Glomerular	6	Nonglomerula	45	Glomerular
199	44	Male	921120C	1628844157	3+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
200	27	Female	746125G	1635144069	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
201	27	Female	527055G	1628844114	1+	Absent	Glomerular	0	Nonglomerula	45	Glomerular
202	49	Male	856397D	1629144217	1+	Absent	Glomerular	7	Nonglomerula	27	Glomerular
203	40	Male	708102G	1629144221	1+	Absent	Glomerular	30	Glomerular	30	Glomerular
204	35	Male	530060G	1629144232	2+	Present	Glomerular	0	Nonglomerula	1	Nonglomerula
205	60	Male	161092C	1629244202	2+	Present	Glomerular	31	Glomerular	48	Glomerular
206	29	Male	650330G	1629244105	2+	Absent	Glomerular	0	Nonglomerula	2	Nonglomerula
207	21	Female	257117B	1629244168	3+	Present	Glomerular	7	Nonglomerula	0	Nonglomerula
208	34	Female	684667G	1629244185	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
209	55	Male	671976A	1629244177	1+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
210	25	Female	456729G	1629244108	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
211	33	Female	711541G	1629244181	1+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
212	52	Male	572414C	1629244187	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
213	69	Female	576207D	1629244193	1+	Present	Glomerular	3	Nonglomerula	5	Nonglomerula
214	42	Male	652291G	1629244041	2+	Present	Glomerular	11	Nonglomerula	25	Nonglomerula
215	47	Male	714697G	1629244029	2+	Present	Glomerular	1	Nonglomerula	2	Nonglomerula
216	62	Male	676334G	1629244050	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
217	56	Male	601914G	1629244070	2+	Present	Nonglomerul	4	Nonglomerula	0	Nonglomerula
218	69	Male	710473G	1629244040	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
219	16	Female	530770G	1629244118	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
220	16	Male	530800G	1629344145	2+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
221	44	Female	393450G	1629344045	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
222	66	Female	363989D	1629344057	1+	Absent	Glomerular	7	Nonglomerula	3	Nonglomerula
223	84	Female	530547G	1629344151	1+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
224	62	Female	530900G	1629344130	2+	Present	Glomerular	0	Nonglomerula	5	Nonglomerula
225	40	Male	693993F	1629344121	1+	Present	Glomerular	0	Nonglomerula	2	Nonglomerula
226	70	Male	530914G	1629344283	1+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
227	43	Female	154848D	1629344192	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
228	52	Female	461441D	1629344364	2+	Absent	Glomerular	4	Nonglomerula	15	Nonglomerula
229	40	Female	392988	1629344328	2+	Absent	Glomerular	0	Nonglomerula	15	Nonglomerula
230	57	Female	674293G	1629344366	1+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
231	50	Female	530451G	1629344371	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
232	20	Female	714930G	1629344388	2+	Present	Glomerular	5	Nonglomerula	10	Nonglomerula
233	30	Female	634536G	1629444034	1+	Present	Glomerular	17	Nonglomerula	5	Nonglomerula
234	52	Male	256098G	1629444033	2+	Present	Nonglomerul	3	Nonglomerula	15	Nonglomerula
235	53	Male	059658F	1629444109	2+	Absent	Nonglomerul	2	Nonglomerula	0	Nonglomerula
236	17	Female	648425G	1629444113	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
237	28	Female	519309D	1629444213	1+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
238	17	Female	702216G	1629444076	2+	Absent	Glomerular	3	Nonglomerula	0	Nonglomerula
239	46	Female	684408G	1629644045	2+	Present	Glomerular	6	Nonglomerula	5	Nonglomerula
240	31	Male	718475G	1629644064	1+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
241	63	Male	713492G	1629644038	2+	Present	Nonglomerul	4	Nonglomerula	0	Nonglomerula
242	22	Male	700890F	1629644044	2+	Absent	Glomerular	1	Nonglomerula	2	Nonglomerula
243	67	Female	948331C	1629644028	1+	Present	Glomerular	2	Nonglomerula	5	Nonglomerula
244	42	Male	450536F	1629644060	1+	Absent	Glomerular	8	Nonglomerula	5	Nonglomerula
245	19	Female	713138G	1629644175	1+	Absent	Glomerular	21	Nonglomerula	2	Nonglomerula
246	57	Male	975431c	1629644179	2+	Present	Glomerular	30	Glomerular	5	Nonglomerula
247	45	Female	717957G	1629644193	1+	Absent	Glomerular	0	Nonglomerula	5	Nonglomerula
248	30	Male	531067G	1629644169	3+	Present	Glomerular	1	Nonglomerula	50	Glomerular
249	85	Female	717086G	1629644095	2+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
250	34	Female	179004G	1629644142	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
251	60	Male	727012C	1629644159	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
252	12	Female	877034D	1629544065	3+	Present	Glomerular	15	Nonglomerula	60	Glomerular
253	45	Male	524313G	1629544084	3+	Present	Glomerular	26	Glomerular	5	Nonglomerula
254	35	Male	602027F	1629544189	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
255	10	Male	617124G	1629544062	3+	Present	Glomerular	10	Nonglomerula	5	Nonglomerula
256	76	Female	052027A	1629544109	1+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
257	82	Female	374234A	1629544148	1+	Absent	Glomerular	5	Nonglomerula	0	Nonglomerula
258	71	Male	631590B	1629544039	2+	Present	Glomerular	3	Nonglomerula	5	Nonglomerula
259	24	Male	719379G	1630144309	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
260	14	Female	076088G	1630144223	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
261	37	Male	531591G	1630144310	3+	Present	Glomerular	21	Nonglomerula	25	Nonglomerula
262	32	Male	174603F	1630144254	2+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
263	62	Female	716270G	1630144283	1+	Absent	Glomerular	6	Nonglomerula	5	Nonglomerula
264	42	Female	811781D	1630144287	2+	Present	Glomerular	11	Nonglomerula	0	Nonglomerula
265	28	Female	713424G	1630144186	3+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
266	53	Female	707924G	1630144103	1+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
267	51	Female	662886G	1630144139	2+	Present	Glomerular	4	Nonglomerula	17	Nonglomerula
268	40	Male	435643F	1629944372	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
269	35	Male	717036G	1629944226	2+	Present	Glomerular	5	Nonglomerula	10	Nonglomerula
270	34	Female	68717G	1630244075	2+	Present	Glomerular	0	Nonglomerula	2	Nonglomerula
271	47	Female	715099G	1630244042	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
272	34	Female	322397D	1630244080	1+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
273	28	Female	531598G	1630244082	1+	Absent	Glomerular	5	Nonglomerula	0	Nonglomerula
274	50	Male	743966F	1630244092	1+	Present	Nonglomerul	4	Nonglomerula	1	Nonglomerula
275	47	Male	714697G	1630244090	2+	Present	Glomerular	3	Nonglomerula	3	Nonglomerula
276	25	Male	531664G	1630244136	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
277	35	Female	717641G	1630244079	2+	Present	Nonglomerular		Nonglomerula	0	Nonglomerula
278	37	Female	722344G	1630244040	3+	Present	Glomerular	10	Nonglomerula	13	Nonglomerula
279	81	Male	718451G	1630244091	1+	Absent	Glomerular	4	Nonglomerula	0	Nonglomerula
280	42	Female	698483G	1630244245	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
281	19	Male	531566G	1630144058	2+	Present	Glomerular	19	Nonglomerula	0	Nonglomerula
282	29	Female	531233G	1630144042	2+	Absent	Glomerular	10	Nonglomerula	10	Nonglomerula
283	63	Male	530146G	1630144075	3+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
284	43	Male	530945G	1630044104	1+	Present	Glomerular	28	Glomerular	64	Glomerular
285	68	Male	881696D	1629844045	2+	Present	Glomerular	22	Nonglomerula	8	Nonglomerula
286	28	Female	531661G	1630244329	1+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
287	34	Female	715895G	1630244137	2+	Present	Nonglomerul	14	Nonglomerula	28	Glomerular
288	54	Male	521028G	1623044308	2+	Present	Glomerular	1	Nonglomerula	12	Nonglomerula
289	17	Female	302204X	1623244152	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
290	51	Male	107521B	1630244168	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
291	42	Male	879861F	1630344083	1+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
292	19	Female	182630G	1630344050	3+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
293	29	Female	532045G	1630644354	1+	Present	Nonglomerul	13	Nonglomerula	0	Nonglomerula
294	10	Female	691328G	1630644350	2+	Present	Glomerular	26	Glomerular	5	Nonglomerula
295	68	Male	629037G	1630644384	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
296	43	Male	497554G	1630644069	1+	Present	Glomerular	15	Nonglomerula	0	Nonglomerula
297	51	Male	719521G	1630644031	2+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
298	23	Female	762057D	1630644040	1+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
299	33	Female	711541G	1630644049	2+	Present	Glomerular	13	Nonglomerula	5	Nonglomerula
300	42	Male	531563G	1630644154	1+	Present	Nonglomerul	6	Nonglomerula	0	Nonglomerula
301	46	Male	725480G	1630644101	2+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
302	17	Male	602965G	1630644128	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
303	41	Female	878470D	1630644115	1+	Present	Glomerular	13	Nonglomerula	0	Nonglomerula
304	32	Female	229177G	1630644132	2+	Present	Glomerular	34	Glomerular	10	Nonglomerula
305	30	Male	660172C	1630644112	1+	Present	Glomerular	8	Nonglomerula	2	Nonglomerula
306	29	Male	531433G	1630644030	1+	Present	Glomerular	9	Nonglomerula	10	Nonglomerula
307	28	Female	531708G	1630544366	2+	Present	Nonglomerul	0	Nonglomerula	5	Nonglomerula
308	61	Female	721639G	1630744092	2+	Present	Nonglomerul	5	Nonglomerula	5	Nonglomerula
309	44	Female	719606G	1630744096	1+	Absent	Nonglomerul	21	Nonglomerula	0	Nonglomerula
310	24	Female	711880G	1630744363	2+	Absent	Nonglomerul	2	Nonglomerula	0	Nonglomerula
311	49	Male	526757C	1630744381	3+	Present	Glomerular	1	Nonglomerula	18	Nonglomerula
312	50	Female	451389G	1630844085	1+	Present	Glomerular	4	Nonglomerula	2	Nonglomerula
313	51	Male	683751G	1630844077	2+	Present	Glomerular	3	Nonglomerula	5	Nonglomerula
314	47	Male	724135G	1630844102	1+	Present	Glomerular	7	Nonglomerula	20	Nonglomerula
315	31	Female	342175G	1630844093	2+	Absent	Glomerular	1	Nonglomerula	1	Nonglomerula
316	25	Female	337550G	1630844089	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
317	68	Male	464521F	1630844169	1+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
318	60	Male	523288G	1630844020	1+	Present	Nonglomerul	39	Glomerular	0	Nonglomerula
319	28	Male	272458D	1630844032	1+	Present	Glomerular	19	Nonglomerula	10	Nonglomerula
320	29	Female	248001G	1630844047	1+	Present	Glomerular	15	Nonglomerula	0	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
321	25	Female	725131G	1630844051	2+	Present	Glomerular	13	Nonglomerula	10	Nonglomerula
322	71	Female	589012C	1630844057	1+	Present	Glomerular	9	Nonglomerula	5	Nonglomerula
323	52	Male	851451F	1630844176	2+	Absent	Glomerular	6	Nonglomerula	22	Nonglomerula
324	67	Male	532219G	1630844259	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
325	54	Female	796512D	1630844281	1+	Present	Glomerular	11	Nonglomerula	0	Nonglomerula
326	46	Female	871227F	1630844246	1+	Absent	Glomerular	8	Nonglomerula	1	Nonglomerula
327	7	Male	466121D	1630844201	2+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
328	60	Male	532233G	1630844345	2+	Present	Nonglomerul	5	Nonglomerula	0	Nonglomerula
329	53	Female	565424D	1630844336	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
330	71	Male	532010G	1630844212	3+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
331	48	Male	610372G	1630844138	1+	Present	Glomerular	0	Nonglomerula	10	Nonglomerula
332	61	Male	474210F	1630844203	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
333	22	Male	723412G	1630844190	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
334	27	Male	713565G	1630844200	1+	Present	Nonglomerul	11	Nonglomerula	0	Nonglomerula
335	49	Female	722560G	1630844251	2+	Absent	Glomerular	3	Nonglomerula	0	Nonglomerula
336	62	Male	106228D	1630844211	2+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
337	70	Male	034579C	1630844154	1+	Present	Nonglomerul	25	Nonglomerula	0	Nonglomerula
338	32	Female	442801F	1630844171	1+	Absent	Glomerular	0	Nonglomerula	3	Nonglomerula
339	49	Male	797877A	1630844160	1+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
340	56	Male	837506D	1630844180	1+	Present	Nonglomerul	6	Nonglomerula	0	Nonglomerula
341	37	Female	115676C	1630844146	2+	Present	Nonglomerul	9	Nonglomerula	0	Nonglomerula
342	25	Female	717125G	1630944091	2+	Absent	Glomerular	2	Nonglomerula	2	Nonglomerula
343	30	Female	722455G	1630944077	1+	Absent	Glomerular	3	Nonglomerula	0	Nonglomerula
344	24	Female	684712G	1630944063	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
345	35	Female	725648G	163044047	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
346	38	Male	723439G	1630944196	2+	Present	Glomerular	5	Nonglomerula	18	Nonglomerula
347	65	Male	521759G	1630944033	1+	Present	Glomerular	15	Nonglomerula	5	Nonglomerula
348	60	Male	716898G	1630944042	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
349	12	Male	612589G	1630944216	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
350	65	Female	869311D	1630944180	1+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
351	58	Male	681235G	1630944149	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
352	44	Male	723980G	1630944170	1+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
353	43	Male	702771G	1630944164	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
354	56	Female	766858D	1630944259	1+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
355	25	Female	711372G	1630944058	3+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
356	28	Male	096872G	1630944036	1+	Absent	Glomerular	4	Nonglomerula	0	Nonglomerula
357	39	Female	664362G	1630944360	1+	Present	Glomerular	7	Nonglomerula	0	Nonglomerula
358	31	Female	730643G	1630944352	1+	Present	Glomerular	4	Nonglomerula	10	Nonglomerula
359	56	Male	530469G	1630944370	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
360	71	Male	705453G	1630944344	1+	Present	Nonglomerul	8	Nonglomerula	0	Nonglomerula
361	22	Male	721957G	1630944312	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
362	36	Female	511471G	1630944301	1+	Absent	Glomerular	6	Nonglomerula	5	Nonglomerula
363	72	Male	618022D	1630944208	2+	Present	Nonglomerul	2	Nonglomerula	1	Nonglomerula
364	39	Male	649248G	1630944236	1+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
365	29	Male	662656G	1630944237	2+	Absent	Glomerular	1	Nonglomerula	2	Nonglomerula
366	32	Female	726956G	1630944269	2+	Absent	Nonglomerul	5	Nonglomerula	5	Nonglomerula
367	46	Female	532284G	1630944267	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
368	43	Female	659304G	1630944229	2+	Absent	Glomerular	3	Nonglomerula	5	Nonglomerula
369	38	Male	725710G	1630944277	2+	Present	Glomerular	15	Nonglomerula	15	Nonglomerula
370	54	Male	718535G	1631044052	1+	Present	Glomerular	2	Nonglomerula	1	Nonglomerula
371	61	Male	726262G	1631044089	1+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
372	56	Male	532337G	1631044097	1+	Present	Glomerular	11	Nonglomerula	1	Nonglomerula
373	48	Male	293028G	1631044062	2+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
374	65	Female	946690F	1631044118	2+	Present	Nonglomerul	45	Glomerular	38	Glomerular
375	5	Female	928334D	1631044090	1+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
376	70	Male	531843g	1631044226	1+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
377	38	Male	648014G	1631044139	2+	Present	Glomerular	25	Nonglomerula	29	Glomerular
378	20	Female	699046G	1631044230	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
379	27	Male	725610G	1631044145	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
380	61	Female	727389G	1631044130	1+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
381	65	Female	532161G	1631044196	3+	Present	Glomerular	16	Nonglomerula	38	Glomerular
382	38	Male	531026G	1631044162	3+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
383	37	Female	719498C	1631044193	2+	Absent	Glomerular	4	Nonglomerula	0	Nonglomerula
384	60	Male	724197G	1631244119	1+	Present	Glomerular	0	Nonglomerula	30	Glomerular
385	44	Male	855763C	1631244174	1+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
386	61	Male	910070F	1631244291	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
387	51	Male	695547G	1631244263	1+	Present	Glomerular	4	Nonglomerula	10	Nonglomerula
388	31	Female	342175G	1631244326	2+	Absent	Glomerular	12	Nonglomerula	10	Nonglomerula
389	28	Female	670444G	1631244271	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
390	24	Male	727262G	1631244255	1+	Present	Glomerular	3	Nonglomerula	5	Nonglomerula
391	41	Female	386770G	1631244254	2+	Present	Glomerular	5	Nonglomerula	10	Nonglomerula
392	38	Male	701330G	1631244175	1+	Absent	Glomerular	7	Nonglomerula	5	Nonglomerula
393	30	Female	532185G	1631244069	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
394	41	Female	221340G	1631244057	2+	Present	Nonglomerul	0	Nonglomerula	5	Nonglomerula
395	30	Female	532551G	1631244049	2+	Present	Nonglomerul	1	Nonglomerula	8	Nonglomerula
396	36	Male	727259G	1631244045	3+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
397	36	Male	491930G	1631244199	2+	Present	Glomerular	5	Nonglomerula	12	Nonglomerula
398	61	Male	636267D	1631244095	2+	Present	Glomerular	5	Nonglomerula	12	Nonglomerula
399	27	Female	719119G	1631244170	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
400	20	Male	982454F	1631244226	3+	Present	Glomerular	22	Nonglomerula	80	Glomerular

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
401	55	Male	696649G	1631244217	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
402	41	Female	568019D	1631244121	3+	Present	Glomerular	34	Glomerular	10	Nonglomerula
403	55	Male	532607G	1631344172	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
404	56	Female	177434D	1631344115	1+	Present	Glomerular	20	Nonglomerula	2	Nonglomerula
405	66	Male	816444D	1631344053	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
406	46	Female	206712G	1631344069	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
407	55	Male	726265G	1631344022	2+	Present	Glomerular	5	Nonglomerula	5	Nonglomerula
408	36	Male	727259G	1631344192	3+	Present	Glomerular	18	Nonglomerula	40	Glomerular
409	36	Male	758167G	1635144039	2+	Present	Glomerular	5	Nonglomerula	8	Nonglomerula
410	58	Female	524054F	1631444205	2+	Present	Nonglomerul	2	Nonglomerula	2	Nonglomerula
411	19	Male	732608G	1631444020	2+	Present	Nonglomerul	3	Nonglomerula	5	Nonglomerula
412	30	Female	733086G	1631444055	2+	Absent	Nonglomerul	2	Nonglomerula	0	Nonglomerula
413	12	Female	196106G	1631444074	1+	Absent	Glomerular	4	Nonglomerula	0	Nonglomerula
414	30	Female	443051G	1631444219	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
415	40	Male	464100G	1631444176	1+	Present	Nonglomerul	4	Nonglomerula	0	Nonglomerula
416	56	Female	719522G	1631444257	2+	Present	Glomerular	18	Nonglomerula	0	Nonglomerula
417	34	Female	188271A	1631444278	1+	Absent	Glomerular	4	Nonglomerula	5	Nonglomerula
418	23	Male	689297G	1631444269	1+	Absent	Nonglomerul	8	Nonglomerula	5	Nonglomerula
419	17	Female	312320F	1631444287	2+	Present	Glomerular	16	Nonglomerula	2	Nonglomerula
420	18	Female	734658G	1631444231	3+	Present	Glomerular	13	Nonglomerula	5	Nonglomerula
421	40	Male	532601G	1631544090	2+	Present	Glomerular	18	Nonglomerula	27	Glomerular
422	53	Female	665451G	1631544033	1+	Absent	Glomerular	8	Nonglomerula	0	Nonglomerula
423	60	Male	734997G	1631644212	1+	Absent	Glomerular	5	Nonglomerula	0	Nonglomerula
424	48	Male	714011G	1631644266	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
425	37	Female	702530G	1631644171	1+	Absent	Nonglomerul	6	Nonglomerula	0	Nonglomerula
426	54	Male	624479G	1631644262	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
427	24	Female	677892G	1631644217	2+	Present	Glomerular	15	Nonglomerula	15	Nonglomerula
428	34	Female	302603G	1631644151	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
429	40	Female	723574G	1631644125	2+	Present	Glomerular	15	Nonglomerula	0	Nonglomerula
430	42	Male	267385D	1631644142	2+	Absent	Glomerular	8	Nonglomerula	0	Nonglomerula
431	66	Female	732404G	1631644057	2+	Present	Glomerular	1	Nonglomerula	2	Nonglomerula
432	31	Female	735432G	1632144029	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
433	65	Male	737989G	1632144163	1+	Present	Glomerular	14	Nonglomerula	0	Nonglomerula
434	75	Female	738060G	1632144103	2+	Present	Glomerular	18	Nonglomerula	10	Nonglomerula
435	23	Female	013052G	1632144091	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
436	53	Female	915650D	1632144055	1+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
437	65	Male	730127G	1632144075	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
438	55	Female	405876B	1632144082	2+	Present	Glomerular	5	Nonglomerula	5	Nonglomerula
439	52	Female	896775D	1632144130	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
440	32	Female	527813G	1632144099	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
441	67	Female	733553G	1632144226	1+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
442	31	Female	714551G	1632144236	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
443	65	Male	506448G	1632144237	1+	Present	Glomerular	8	Nonglomerula	10	Nonglomerula
444	50	Female	733769G	1632144162	3+	Present	Glomerular	4	Nonglomerula	57	Glomerular
445	42	Male	738458G	1632144288	1+	Present	Glomerular	27	Glomerular	0	Nonglomerula
446	15	Female	708277G	1632144227	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
447	25	Female	534239G	1632144216	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
448	31	Female	801004F	1632244105	1+	Absent	Glomerular	8	Nonglomerula	0	Nonglomerula
449	29	Male	737589G	1632244026	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
450	65	Male	008307F	1632244114	1+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
451	46	Male	735121G	1632244142	2+	Present	Nonglomerul	6	Nonglomerula	0	Nonglomerula
452	49	Female	484232G	1632244089	2+	Present	Glomerular	11	Nonglomerula	0	Nonglomerula
453	31	Female	208969C	1632244069	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
454	53	Female	948666F	1632244031	3+	Present	Glomerular	11	Nonglomerula	0	Nonglomerula
455	25	Male	736384G	1632244241	1+	Present	Nonglomerul	11	Nonglomerula	0	Nonglomerula
456	43	Female	726825G	1632244203	2+	Absent	Nonglomerul	2	Nonglomerula	0	Nonglomerula
457	45	Male	738083G	1632244265	1+	Present	Glomerular	15	Nonglomerula	15	Nonglomerula
458	38	Female	712963G	1632244255	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
459	34	Male	445551G	1632244288	2+	Present	Glomerular	14	Nonglomerula	2	Nonglomerula
460	32	Male	223134G	1621144091	1+	Absent	Glomerular	20	Nonglomerula	20	Nonglomerula
461	42	Female	486267G	1621644022	3+	Present	Glomerular	12	Nonglomerula	35	Glomerular
462	33	Male	835850F	1620744144	2+	Absent	Glomerular	15	Nonglomerula	60	Glomerular
463	54	Male	340316G	1620744148	1+	Absent	Nonglomerul	3	Nonglomerula	0	Nonglomerula
464	49	Female	223287G	1620744124	3+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
465	45	Female	862016D	1621144033	2+	Present	Nonglomerul	1	Nonglomerula	12	Nonglomerula
466	40	Female	516872G	1620844052	2+	Present	Glomerular	2	Nonglomerula	30	Glomerular
467	25	Male	639586G	1620844065	2+	Present	Nonglomerul	10	Nonglomerula	20	Nonglomerula
468	67	Male	648284G	1621144036	3+	Present	Glomerular	2	Nonglomerula	10	Nonglomerula
469	36	Male	758167G	163544039	2+	Present	Glomerular	5	Nonglomerula	8	Nonglomerula
470	16	Female	318285F	1618944237	2+	Present	Glomerular	23	Nonglomerula	20	Nonglomerula
471	55	Male	817518F	1619644070	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
472	38	Female	520427F	1619044261	2+	Present	Glomerular	5	Nonglomerula	10	Nonglomerula
473	42	Male	627475G	1619044143	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
474	50	Female	623964G	1619044128	3+	Present	Nonglomerul	2	Nonglomerula	5	Nonglomerula
475	55	Male	633460G	1619044224	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
476	54	Male	663979D	1619044175	3+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
477	30	Male	634890G	1619744040	2+	Present	Glomerular	3	Nonglomerula	15	Nonglomerula
478	37	Female	514980G	1620144144	1+	Present	Glomerular	7	Nonglomerula	15	Nonglomerula
479	54	Male	290665C	1619744211	1+	Absent	Nonglomerul	7	Nonglomerula	10	Nonglomerula
480	31	Male	704672C	1623844165	2+	Present	Glomerular	10	Nonglomerula	10	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
481	26	Female	489731G	1623944029	1+	Present	Glomerular	10	Nonglomerula	15	Nonglomerula
482	37	Male	518339G	1623644300	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
483	40	Female	666519G	1623644108	3+	Present	Glomerular	11	Nonglomerula	50	Glomerular
484	68	Male	671180G	1624344233	1+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
485	43	Male	521057F	1624344135	2+	Absent	Glomerular	21	Nonglomerula	50	Glomerular
486	49	Male	668285G	1624344059	2+	Present	Glomerular	14	Nonglomerula	40	Glomerular
487	18	Male	521904G	1624044107	3+	Present	Glomerular	5	Nonglomerula	40	Glomerular
488	26	Female	331522F	1624044111	2+	Present	Glomerular	39	Glomerular	80	Glomerular
489	63	Male	521364F	1623644063	3+	Present	Glomerular	14	Nonglomerula	50	Glomerular
490	36	Male	521372F	1622944041	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
491	43	Female	520678G	1629944115	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
492	43	Male	520973F	1629944124	1+	Present	Nonglomerul	6	Nonglomerula	0	Nonglomerula
493	25	Male	656943G	1622644042	2+	Present	Nonglomerul	17	Nonglomerula	15	Nonglomerula
494	69	Female	661515G	1622644032	3+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
495	45	Female	594263X	1622544213	3+	Present	Glomerular	14	Nonglomerula	50	Glomerular
496	45	Female	521114G	1623044154	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
497	26	Female	520933G	1623044107	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
498	51	Male	518704G	1623044062	3+	Present	Glomerular	9	Nonglomerula	15	Nonglomerula
499	58	Male	662011G	1623044156	1+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
500	34	Female	244122G	1635144031	2+	Present	Glomerular	7	Nonglomerula	5	Nonglomerula
501	20	Female	510933C	1632344088	2+	Present	Nonglomerul	1	Nonglomerula	5	Nonglomerula
502	18	Female	534367G	1632344181	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
503	51	Male	734616G	1632344112	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
504	48	Female	534125G	1632344098	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
505	28	Female	531661G	1632344104	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
506	60	Female	695654G	1632344146	2+	Present	Glomerular	33	Glomerular	15	Nonglomerula
507	40	Female	702814G	1632344118	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
508	46	Female	534242G	1632344079	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
509	29	Female	643429G	1632344178	3+	Present	Glomerular	28	Glomerular	20	Nonglomerula
510	63	Male	064404D	1632344070	1+	Absent	Glomerular	4	Nonglomerula	0	Nonglomerula
511	65	Male	721276G	1632344031	2+	Present	Nonglomerul	8	Nonglomerula	0	Nonglomerula
512	39	Male	720577G	1632344349	1+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
513	24	Female	470901F	1632344348	2+	Absent	Glomerular	3	Nonglomerula	0	Nonglomerula
514	23	Female	302367F	1632344353	1+	Absent	Glomerular	4	Nonglomerula	0	Nonglomerula
515	30	Male	737238G	1632344336	2+	Present	Glomerular	16	Nonglomerula	5	Nonglomerula
516	50	Male	737672G	1632344356	2+	Present	Glomerular	6	Nonglomerula	10	Nonglomerula
517	38	Male	738968G	1632344347	2+	Present	Glomerular	7	Nonglomerula	0	Nonglomerula
518	88	Female	520158B	1632444099	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
519	40	Female	378717C	1632444071	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
520	68	Male	110802C	1632444190	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
521	35	Female	737558G	1632444189	2+	Present	Glomerular	5	Nonglomerula	10	Nonglomerula
522	30	Male	781317D	1632644140	2+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
523	24	Male	258329G	1632644120	1+	Present	Glomerular	11	Nonglomerula	3	Nonglomerula
524	53	Male	741729G	1632644117	2+	Absent	Glomerular	21	Nonglomerula	5	Nonglomerula
525	31	Male	741471G	1632644080	1+	Present	Nonglomerul	5	Nonglomerula	0	Nonglomerula
526	32	Male	106946G	1632644062	2+	Present	Glomerular	19	Nonglomerula	10	Nonglomerula
527	55	Male	488659G	1632644066	1+	Present	Glomerular	21	Nonglomerula	0	Nonglomerula
528	46	Male	700327A	1632644039	1+	Present	Glomerular	6	Nonglomerula	5	Nonglomerula
529	27	Female	648426G	1632644063	1+	Present	Glomerular	7	Nonglomerula	18	Nonglomerula
530	64	Male	737580G	1632644077	2+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
531	36	Male	731933G	1632644037	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
532	65	Male	534615G	1632644071	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
533	29	Female	920510F	1632644078	1+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
534	45	Male	689508G	1632644095	1+	Present	Glomerular	6	Nonglomerula	5	Nonglomerula
535	63	Female	693539G	1632644152	2+	Present	Glomerular	4	Nonglomerula	30	Glomerular
536	56	Male	432640G	1632644290	1+	Present	Glomerular	28	Glomerular	0	Nonglomerula
537	24	Male	961987F	1632644302	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
538	40	Female	716016G	1632644184	2+	Absent	Glomerular	29	Glomerular	15	Nonglomerula
539	18	Male	742020G	1632644322	2+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
540	33	Female	739612G	1632644274	3+	Present	Nonglomerul	4	Nonglomerula	0	Nonglomerula
541	49	Female	567457B	1632744246	1+	Absent	Glomerular	9	Nonglomerula	0	Nonglomerula
542	43	Female	445722B	1632744325	1+	Present	Glomerular	7	Nonglomerula	0	Nonglomerula
543	40	Male	524282F	1632744300	2+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
544	37	Female	990155F	1632744328	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
545	16	Male	725536G	1632744358	1+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
546	44	Male	216576G	1632744219	2+	Present	Glomerular	20	Nonglomerula	13	Nonglomerula
547	67	Female	616516B	1632744196	1+	Present	Nonglomerul	10	Nonglomerula	0	Nonglomerula
548	49	Male	740335G	1632744310	1+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
549	46	Female	682835G	1632744260	2+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
550	41	Female	740772G	1632744267	2+	Present	Glomerular	5	Nonglomerula	12	Nonglomerula
551	55	Male	863432F	1632744129	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
552	49	Male	534706G	1632744214	2+	Present	Glomerular	11	Nonglomerula	5	Nonglomerula
553	50	Male	753571G	1635144139	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
554	34	Female	385462F	1632744092	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
555	45	Female	534550G	1632744105	1+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
556	29	Female	741699G	1632844044	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
557	48	Male	685187A	1632844143	2+	Present	Glomerular	3	Nonglomerula	10	Nonglomerula
558	38	Female	743142G	1632844057	2+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
559	40	Female	362809G	1632844124	2+	Present	Glomerular	11	Nonglomerula	0	Nonglomerula
560	63	Male	731349G	1632844205	1+	Present	Glomerular	15	Nonglomerula	5	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
561	50	Female	733769G	1632844109	2+	Present	Glomerular	6	Nonglomerula	26	Glomerular
562	66	Female	116384A	1632844101	2+	Absent	Glomerular	15	Nonglomerula	0	Nonglomerula
563	54	Male	571150D	1632844028	1+	Present	Glomerular	16	Nonglomerula	5	Nonglomerula
564	10	Female	439503G	1635144043	1+	Absent	Glomerular	3	Nonglomerula	5	Nonglomerula
565	60	Female	682474G	1632844192	1+	Present	Nonglomerul	8	Nonglomerula	0	Nonglomerula
566	61	Male	896421D	1632844197	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
567	36	Male	650391G	1632844220	1+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
568	39	Female	740365G	1632844258	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
569	29	Female	756576F	1632844273	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
570	19	Female	534490G	1632944051	2+	Present	Glomerular	14	Nonglomerula	26	Glomerular
571	41	Female	045506G	1632944022	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
572	45	Female	743620G	1632944029	2+	Present	Glomerular	21	Nonglomerula	0	Nonglomerula
573	74	Male	733950G	1632944144	3+	Present	Nonglomerul	9	Nonglomerula	0	Nonglomerula
574	35	Female	737558G	1632944142	2+	Present	Glomerular	1	Nonglomerula	5	Nonglomerula
575	36	Female	534819G	1632944148	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
576	24	Male	658961G	1632944077	1+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
577	45	Male	707422G	1632944095	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
578	28	Male	641931G	1632944134	2+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
579	67	Female	946206C	1632944156	2+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
580	60	Female	329830F	1632944204	3+	Present	Glomerular	21	Nonglomerula	10	Nonglomerula
581	14	Female	517955G	1632944207	2+	Present	Nonglomerul	5	Nonglomerula	0	Nonglomerula
582	40	Male	435643F	1632944206	2+	Present	Glomerular	21	Nonglomerula	0	Nonglomerula
583	59	Male	437598F	1632944169	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
584	22	Female	739659G	1632944246	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
585	22	Female	247385F	1632944196	2+	Absent	Glomerular	2	Nonglomerula	0	Nonglomerula
586	35	Male	735393G	1632944244	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
587	46	Female	371103G	1632944227	1+	Present	Nonglomerul	6	Nonglomerula	0	Nonglomerula
588	57	Male	744210G	1633044032	1+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
589	33	Female	714562B	1633044021	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
590	36	Male	743943G	1633044053	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
591	48	Female	702837G	1633044045	2+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
592	24	Female	470510G	1633044076	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
593	21	Female	534760G	1633044063	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
594	61	Male	532358G	1633044066	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
595	57	Male	711815G	1633044089	1+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
596	66	Male	725420C	1633044112	1+	Present	Nonglomerul	2	Nonglomerula	5	Nonglomerula
597	40	Male	695877G	1633044135	1+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
598	35	Male	734968G	1633044105	1+	Absent	Glomerular	3	Nonglomerula	0	Nonglomerula
599	26	Male	272306G	1633044154	1+	Absent	Glomerular	6	Nonglomerula	0	Nonglomerula
600	26	Female	986690B	1633044200	3+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
601	58	Female	869074	1633044199	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
602	49	Female	742421G	1633044191	2+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
603	66	Male	865594D	1633044339	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
604	23	Female	534901G	1633044313	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
605	84	Male	853093A	1633044302	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
606	31	Female	745650G	1633044317	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
607	55	Female	942963A	1633044323	1+	Absent	Glomerular	5	Nonglomerula	0	Nonglomerula
608	62	Male	645061G	1633044300	2+	Present	Glomerular	18	Nonglomerula	23	Nonglomerula
609	52	Male	711481G	1633044330	2+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
610	56	Female	307541A	1633044315	1+	Present	Glomerular	5	Nonglomerula	5	Nonglomerula
611	32	Male	273463F	1633044304	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
612	50	Male	490062G	1633044294	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
613	70	Female	742311G	1633044215	1+	Absent	Glomerular	4	Nonglomerula	0	Nonglomerula
614	42	Female	089490D	1633044214	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
615	21	Female	744348G	1633044232	2+	Present	Glomerular	3	Nonglomerula	5	Nonglomerula
616	32	Male	741349G	1633044205	2+	Present	Glomerular	23	Nonglomerula	10	Nonglomerula
617	70	Male	534896G	1633044290	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
618	29	Male	721082G	1633044252	1+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
619	34	Female	716127G	1633044253	2+	Absent	Nonglomerul	6	Nonglomerula	0	Nonglomerula
620	64	Female	665082C	1634044224	2+	Present	Glomerular	2	Nonglomerula	5	Nonglomerula
621	57	Female	720049G	1633044326	1+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
622	47	Female	645202G	1633044263	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
623	37	Female	730893G	1633044248	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
624	44	Male	743343G	1633044259	2+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
625	41	Male	709016G	1633044234	2+	Present	Glomerular	16	Nonglomerula	0	Nonglomerula
626	25	Female	739776G	1633044155	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
627	65	Male	683423D	1633044228	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
628	34	Female	686077C	1633044218	2+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
629	13	Female	235586G	1635144058	2+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
630	37	Female	165807G	1633444237	2+	Absent	Nonglomerul	19	Nonglomerula	5	Nonglomerula
631	19	Female	741363G	1633444254	3+	Present	Nonglomerul	23	Nonglomerula	0	Nonglomerula
632	29	Female	779216C	1633444246	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
633	40	Female	181337D	1633444027	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
634	35	Female	719587G	1633444029	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
635	44	Male	625595G	1633444245	3+	Present	Glomerular	8	Nonglomerula	5	Nonglomerula
636	38	Female	454239F	1633444206	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
637	19	Male	746023G	1633444240	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
638	48	Female	702837G	1633444189	1+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
639	21	Female	278716F	1633444225	3+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
640	55	Male	735029G	1633444161	1+	Absent	Glomerular	5	Nonglomerula	0	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
641	26	Female	785760A	1633444265	2+	Absent	Glomerular	19	Nonglomerula	0	Nonglomerula
642	47	Male	319775F	1633444371	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
643	42	Female	616755G	1633444174	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
644	42	Male	747182G	1633444158	1+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
645	30	Female	747918G	1633444190	1+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
646	49	Female	405135F	1633444212	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
647	72	Male	747137G	1633444192	1+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
648	53	Male	984602F	1633444176	2+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
649	75	Female	882967C	1633444185	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
650	22	Female	247379F	1633444314	3+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
651	43	Female	744996G	1633444338	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
652	58	Male	743243G	1633444311	1+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
653	63	Female	744177G	1633444341	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
654	17	Male	744063G	1633444355	2+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
655	54	Male	718572G	1633444422	2+	Absent	Nonglomerul	15	Nonglomerula	5	Nonglomerula
656	27	Female	511579G	1633444372	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
657	20	Female	347206G	1633444356	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
658	84	Male	794719C	1633444423	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
659	61	Female	746982G	1633544216	1+	Absent	Nonglomerul	0	Nonglomerula	5	Nonglomerula
660	38	Male	534897G	1633544106	2+	Present	Glomerular	6	Nonglomerula	28	Glomerular
661	61	Male	639554F	1633744252	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
662	6	Male	504288G	1633744206	3+	Present	Glomerular	1	Nonglomerula	5	Nonglomerula
663	74	Male	749318G	1633744202	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
664	70	Male	749302G	1633744272	2+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
665	51	Female	688452G	1633744220	1+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
666	70	Female	749404G	1633744290	1+	Present	Glomerular	8	Nonglomerula	5	Nonglomerula
667	43	Male	746487G	1633744287	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
668	52	Male	745505G	1633744247	2+	Present	Glomerular	0	Nonglomerula	5	Nonglomerula
669	13	Female	746356G	1633744259	1+	Present	Glomerular	11	Nonglomerula	0	Nonglomerula
670	30	Male	108518G	1633744260	1+	Present	Glomerular	10	Nonglomerula	5	Nonglomerula
671	32	Male	527138G	1633744021	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
672	40	Male	748593G	1633744025	1+	Absent	Glomerular	2	Nonglomerula	0	Nonglomerula
673	15	Female	628873G	1633744149	2+	Present	Glomerular	16	Nonglomerula	5	Nonglomerula
674	12	Female	877034D	1633744038	3+	Present	Glomerular	14	Nonglomerula	26	Glomerular
675	54	Female	162593C	1633744042	1+	Absent	Glomerular	2	Nonglomerula	0	Nonglomerula
676	13	Male	747658G	1633744046	1+	Absent	Nonglomerul	5	Nonglomerula	0	Nonglomerula
677	29	Female	796166F	1633844093	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
678	61	Male	748016G	1633844109	1+	Absent	Glomerular	9	Nonglomerula	0	Nonglomerula
679	86	Male	795108D	1633844150	1+	Absent	Nonglomerul	9	Nonglomerula	0	Nonglomerula
680	57	Male	743437G	1633844130	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
681	50	Male	148180F	1633844162	1+	Absent	Glomerular	15	Nonglomerula	0	Nonglomerula
682	79	Female	215492C	1633844134	1+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
683	46	Male	794445A	1633844188	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
684	35	Male	473136G	1633844170	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
685	34	Female	115983G	1634044122	2+	Present	Nonglomerul	2	Nonglomerula	16	Nonglomerula
686	36	Female	749405G	1634044143	2+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
687	22	Female	461712D	1634044105	1+	Absent	Glomerular	3	Nonglomerula	0	Nonglomerula
688	30	Male	660172C	1634044092	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
689	34	Female	612962G	1634044177	2+	Absent	Glomerular	12	Nonglomerula	0	Nonglomerula
690	35	Female	691220G	1634044174	2+	Absent	Glomerular	22	Nonglomerula	26	Glomerular
691	22	Male	198384B	1634044184	2+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
692	54	Male	664277G	1634044167	2+	Present	Glomerular	22	Nonglomerula	0	Nonglomerula
693	43	Male	611820G	1634044202	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
694	46	Male	677329G	1634044086	1+	Present	Glomerular	0	Nonglomerula	5	Nonglomerula
695	48	Male	605327G	1634044205	2+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
696	65	Female	746246G	1634044130	1+	Absent	Glomerular	2	Nonglomerula	0	Nonglomerula
697	47	Female	735506G	1634044238	1+	Present	Glomerular	0	Nonglomerula	5	Nonglomerula
698	49	Male	751253G	1634044254	1+	Absent	Glomerular	2	Nonglomerula	0	Nonglomerula
699	40	Female	671215G	1634044213	1+	Absent	Glomerular	0	Nonglomerula	5	Nonglomerula
700	37	Female	536624G	1634044219	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
701	83	Male	731323G	1634144048	2+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
702	46	Male	750780G	1634144029	1+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
703	15	Female	745431G	1634144108	2+	Present	Nonglomerul	5	Nonglomerula	0	Nonglomerula
704	1	Female	405678G	1634144063	2+	Absent	Glomerular	4	Nonglomerula	5	Nonglomerula
705	55	Male	710174G	1634144076	2+	Present	Glomerular	12	Nonglomerula	0	Nonglomerula
706	63	Male	747344G	1634144073	2+	Present	Glomerular	1	Nonglomerula	15	Nonglomerula
707	40	Female	752352G	1634144070	1+	Absent	Glomerular	2	Nonglomerula	5	Nonglomerula
708	32	Female	701923G	1634144090	2+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
709	54	Male	745577G	1634144147	1+	Present	Nonglomerul	7	Nonglomerula	0	Nonglomerula
710	65	Male	748229G	1634144188	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
711	33	Female	022969C	1634144031	1+	Absent	Glomerular	2	Nonglomerula	5	Nonglomerula
712	18	Female	536412G	1634144176	1+	Present	Glomerular	23	Nonglomerula	0	Nonglomerula
713	48	Female	753402G	1634344130	1+	Absent	Glomerular	1	Nonglomerula	0	Nonglomerula
714	28	Female	524132G	1634344140	2+	Present	Glomerular	3	Nonglomerula	3	Nonglomerula
715	44	Female	635716B	1634344146	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
716	49	Female	664730G	1634344072	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
717	34	Female	653278G	1634344079	1+	Absent	Glomerular	3	Nonglomerula	0	Nonglomerula
718	34	Female	218529D	1634344109	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
719	34	Female	196113D	1634344108	3+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
720	61	Male	534775G	1634344070	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula

Sl no	Age	Sex	Hospital no	Clinpath no	Dipstick	Proteinuria	Sysmex	IRIS%	IRIS	PCM%	PCM
721	21	Female	703698A	1634344210	1+	Absent	Glomerular	6	Nonglomerula	0	Nonglomerula
722	43	Male	733562B	1634344203	2+	Present	Glomerular	3	Nonglomerula	20	Nonglomerula
723	48	Male	708375G	1634344219	1+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
724	33	Male	692923G	1634344199	1+	Present	Glomerular	1	Nonglomerula	15	Nonglomerula
725	14	Female	765795F	1635144122	3+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
726	25	Male	697496G	1634344235	1+	Absent	Glomerular	2	Nonglomerula	18	Nonglomerula
727	64	Male	087193A	1634344265	2+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
728	19	Female	727716G	1634344268	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
729	51	Male	103507D	1635144102	2+	Present	Glomerular	1	Nonglomerula	10	Nonglomerula
730	46	Female	747057G	1634344218	1+	Absent	Glomerular	5	Nonglomerula	12	Nonglomerula
731	27	Male	526871G	1634444111	2+	Present	Glomerular	18	Nonglomerula	0	Nonglomerula
732	31	Male	751960G	1634444027	2+	Present	Nonglomerul	0	Nonglomerula	15	Nonglomerula
733	66	Female	706879G	1634444234	2+	Present	Glomerular	5	Nonglomerula	15	Nonglomerula
734	45	Female	536860G	1634444149	1+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
735	30	Female	742135G	1634444166	2+	Present	Nonglomerul	0	Nonglomerula	0	Nonglomerula
736	15	Male	751196G	163444101	2+	Absent	Glomerular	5	Nonglomerula	0	Nonglomerula
737	58	Female	536890G	1634444107	1+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
738	57	Male	743437G	1634444059	2+	Present	Nonglomerul	0	Nonglomerula	5	Nonglomerula
739	45	Male	746391G	1634444045	2+	Present	Glomerular	3	Nonglomerula	0	Nonglomerula
740	42	Female	196764F	1634444043	1+	Absent	Glomerular	9	Nonglomerula	5	Nonglomerula
741	50	Female	346699F	1634444163	1+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
742	42	Female	735477G	1634444232	1+	Absent	Glomerular	18	Nonglomerula	8	Nonglomerula
743	29	Female	754831G	1634444316	1+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
744	32	Female	754567G	1634444270	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
745	40	Male	247978G	1634444329	1+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
746	55	Female	710771G	1634444304	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
747	25	Female	715575G	1634444349	1+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
748	45	Male	536022G	1634244200	1+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
749	31	Male	753159G	1634844329	2+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
750	71	Male	744462G	1634844328	1+	Present	Glomerular	6	Nonglomerula	0	Nonglomerula
751	63	Male	753767G	1634844059	1+	Present	Glomerular	3	Nonglomerula	5	Nonglomerula
752	60	Male	395583F	1634844133	1+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
753	26	Female	753763G	1634844057	2+	Present	Glomerular	28	Glomerular	26	Glomerular
754	50	Male	446394G	1634844075	1+	Present	Glomerular	13	Nonglomerula	23	Nonglomerula
755	56	Male	752326G	1634844129	3+	Present	Glomerular	6	Nonglomerula	10	Nonglomerula
756	55	Female	237832F	1634844132	2+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
757	38	Female	724383G	1634844013	1+	Absent	Glomerular	0	Nonglomerula	5	Nonglomerula
758	67	Male	536796G	1634844192	2+	Present	Glomerular	0	Nonglomerula	0	Nonglomerula
759	52	Male	581884B	1634844052	2+	Absent	Glomerular	8	Nonglomerula	15	Nonglomerula
760	79	Male	357188	1634844343	3+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
761	20	Female	750981G	1634844140	2+	Present	Glomerular	2	Nonglomerula	5	Nonglomerula
762	25	Male	756189G	1634844128	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
763	49	Female	722560G	1632344050	2+	Absent	Glomerular	5	Nonglomerula	0	Nonglomerula
764	5	Male	068044F	1634844277	1+	Present	Nonglomerul	3	Nonglomerula	0	Nonglomerula
765	24	Female	161943G	1634844285	2+	Absent	Nonglomerul	2	Nonglomerula	0	Nonglomerula
766	40	Male	754493G	1634844288	1+	Present	Glomerular	2	Nonglomerula	5	Nonglomerula
767	44	Female	755499G	1634844264	1+	Present	Glomerular	7	Nonglomerula	0	Nonglomerula
768	73	Male	509421C	1634944030	1+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
769	35	Female	258715D	1634944153	2+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
770	39	Female	481677G	1634944159	3+	Absent	Nonglomerul	1	Nonglomerula	0	Nonglomerula
771	64	Male	754428G	1634944111	2+	Present	Glomerular	3	Nonglomerula	26	Glomerular
772	13	Female	897656F	1634944117	2+	Absent	Nonglomerul	2	Nonglomerula	0	Nonglomerula
773	31	Male	661966G	1634944151	1+	Present	Glomerular	10	Nonglomerula	0	Nonglomerula
774	40	Male	539273G	1634944261	1+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
775	49	Female	756906G	1634944257	2+	Present	Glomerular	18	Nonglomerula	0	Nonglomerula
776	69	Male	451160D	1634944296	2+	Present	Nonglomerul	2	Nonglomerula	0	Nonglomerula
777	54	Male	721310G	1634944245	3+	Present	Nonglomerul	1	Nonglomerula	5	Nonglomerula
778	45	Male	539270G	1634944295	1+	Present	Nonglomerul	9	Nonglomerula	0	Nonglomerula
779	49	Male	756377G	1634944226	2+	Present	Glomerular	4	Nonglomerula	0	Nonglomerula
780	81	Female	466849G	1634944238	1+	Present	Nonglomerul	28	Glomerular	0	Nonglomerula
781	49	Male	834485D	1634944221	1+	Present	Glomerular	8	Nonglomerula	0	Nonglomerula
782	16	Male	539112G	1635044043	2+	Present	Glomerular	5	Nonglomerula	0	Nonglomerula
783	44	Female	720213G	1635044139	2+	Absent	Glomerular	0	Nonglomerula	0	Nonglomerula
784	16	Female	318285F	1635044098	1+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula
785	54	Female	961295D	1635044142	2+	Present	Glomerular	2	Nonglomerula	0	Nonglomerula
786	34	Female	539345G	1635044151	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
787	67	Male	539229G	1635044161	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
788	38	Female	808422F	1634844213	2+	Absent	Nonglomerul	4	Nonglomerula	0	Nonglomerula
789	18	Female	758287G	1635044246	2+	Present	Glomerular	1	Nonglomerula	0	Nonglomerula
790	33	Male	757598G	1635044239	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
791	38	Female	755831G	1635044214	2+	Present	Glomerular	12	Nonglomerula	0	Nonglomerula
792	65	Male	539323G	1635044263	1+	Present	Nonglomerul	4	Nonglomerula	5	Nonglomerula
793	50	Male	421964D	1635044199	1+	Present	Glomerular	6	Nonglomerula	10	Nonglomerula
794	50	Male	758613G	1635044291	2+	Present	Nonglomerul	1	Nonglomerula	0	Nonglomerula
795	48	Male	748003G	1635144056	1+	Absent	Nonglomerul	0	Nonglomerula	0	Nonglomerula
796	39	Male	714988F	1635144143	1+	Absent	Nonglomerul	4	Nonglomerula	0	Nonglomerula
797	45	Male	447826G	1635144118	1+	Present	Nonglomerul	8	Nonglomerula	0	Nonglomerula
798	69	Male	749783G	1635144168	1+	Absent	Glomerular	8	Nonglomerula	0	Nonglomerula
799	42	Female	539339G	1635144169	2+	Present	Glomerular	13	Nonglomerula	5	Nonglomerula
800	37	Male	754867G	1635144071	2+	Present	Glomerular	9	Nonglomerula	0	Nonglomerula

10.4. Standard operating procedure for Sysmex UX-2000

	Document Name	CMCTMIH - CPSOPUS
	Version	2.0

2.0 Procedure to use the UX 2000 urine analyzer

2.1 Purpose of examination:

To increase workflow efficiency and provide accurate results every time and eventually increase the laboratories productivity.

2.2 Principle and method of examination:

S.No.	Test	Principle
1	Test strip	Dual wave length reflectance method.
2	Specific gravity	Transmission refractrometry.
3	Colour hue	Reflectivity measurement method.
4	Turbidity	Light scattering measurement method.

2.3 Performance characteristics:

1. For urine chemistry tests alone 200 samples/ Hr.
2. On flow cytometry alone 100 samples/ Hr.
3. In cases when chemistry is followed by flow cytometry it can process 150 samples/ Hr.

2.4 Type of sample:

1. Urine specimen.

2.5 Type of container and additives:

1. 9.5 mL Vacutte evacuated urine tube with a yellow cap.

2.6 Required equipment and reagents:

1. 6 mL urine sample.
   a. 2 mL for Chemistry.
   b. 4 mL for flow cytometry.

2.7 Environment and safety controls:

Follow standard precautions.

2.8 Procedural steps:

2.8.1 Startup (Daily Maintenance):

1. Inspect the reagents/ waste containers.
2. Turn on peripherals (power switches).
3. Turn on the IPU.
4. Turn on the main unit.
5. Press the start up switch.

Reviewed By	Authorized By	Issued	Revision	Effective from	Page Number
		18/05/2015	0	19/05/2015	5/33
Quality Manager	HOD				

2.8.2 Analysis:

1. Mix the urine samples by repeated inversions of the evacuated urine tube. Ensure the urine samples in the evacuated tube are bar coded before starting the analysis.
2. Remove the cap of the vacutainer and place the urine sample in the "loading table".
3. Activate the "Sampler Start" command on the screen.
4. The analyzer automatically analyses the chemistry of the urine sample if it is normal it gets "auto validated".
5. If any value exceeds the cut off for limits it automatically goes for reflex flow cytometry analysis as per protocol. I.e. Blood > 1+; Protein > 1+; Nitrite > 1+; leukocyte > 1+.

2.8.3 Shut down (Daily Maintenance):

1. Double click the shutdown icon on the screen.
2. Perform shutdown on the main unit.
3. Power off the main unit and exit the IPU.
4. Shutdown the operating system (computer).
5. Power off the printer.

2.9 C procedures:

1. There are two levels of Quality Control materials are used. One is Low (negative control) and the other is high (Positive control).

2.9.1 Registration of C lot:

1. Double click on the QC icon.
2. Select the CHM or FCM QC files and select an empty position and click edit.
3. Scan the barcodes on the QC insert for each individual parameter and ensure the values are updated on the screen.

2.9.2 Meditape Check 1 and 2 preparation:

1. Allow meditape check 1 and 2 to return to room temperature 15 to 25°C.
2. Add whole diluents to the Lyophilized urine in the bottle.
3. Mix the lyophilized urine bottle by gentle inversion without bubble formation and allow to stand for 5 min.
4. Transfer an adequate amount of the diluted QC material into the recommended urine vacutainer.

2.9.3 Chemistry (CHM) C:

1. Double click QC.
2. Select "CHM- QC analysis".
3. Select the QC files.
4. Place QC materials in positions 1(low) and 4 (High) (Note: - the position may not be in sequence refer to picture in the dialogue box).
5. Load sample racks with the QC material on the loading table.

Note: -

"CHM- QC can be analyzed in the sampler mode only".

2.9.4 UF II control preparation:

1. Allow UF II control to get to ambient room temperature before use (15- 30°C).
2. Shake vigorously another 20 times.
3. Double click "QC" on the screen, select "FCM for QC analysis".
4. Immediately (within 10 seconds) after mixing dispenses 12- 14 drop (950 µL) of QC materials into the respective sample cups.
5. Place the sample cup in the FCM (Flow cytometry) nozzle.
6. Press the "START" switch after which the QC results will be displayed on the screen.
7. Select "QC files" and accept the results if acceptable range. If not acceptable re run the QC.

2.9.5 Flow cytometry (FCM) uality analysis:

1. Double click QC.
2. Select "FCM- QC analysis".
3. Select the QC files.
4. Select ok and prepare the QC material and place it under the FCM aspiration pipette.
5. Press the manual analysis switch.

Note: -

"FCM- QC can be analyzed in manual mode only".

2.9.6 C results:

1. Double click QC.
2. Select CHM/ FCM- QC files.
3. Double click the desired QC files.
4. Levy- Jennings chart will be displayed.
5. Check if the results are within the recommended limits (±2SD).

2.10 Calibration:

1. Performed using the UF II calibrator.
2. Routine calibration has to be performed every 6 months.
3. Other conditions when calibration must be performed
    a. When the QC indicates change in sensitivity.
    b. When components of optical units are replaced.
    c. When electric circuits are repaired.
4. UF II traceability to
    a. ICSH expert panel on flow cytometry, clinical laboratory haematology, 16, 131-138, 1994 "Reference method for enumeration of erythrocytes and leucocytes".

2.11 Interference:

1. High sensitivity sample with pyuria.
2. Macroscopic hematuria samples.
3. Samples with high concentration of mucus strands.
4. Samples with fluorescent materials due to inclusion of chemicals.
5. Samples that include preservatives.
6. Pooled urine.

2.12 Results:

Parameter	Positives
Bilirubin	1+ to 2+ (0.5- 4mg/ dL)
Blood	2+ to 3+ (0.2- ≥ 1mg/ dL).
Glucose	2+ to 4+ (150- 1000 mg/ dL)
Ketone	1+ to 3+ (10- 100 mg/ dL).
Leukocytes	1+ to 3+ (75- 500 leu/ µL)
Nitrite	1+ to 2+
pH	6.5 to 8.0
Protein	1+ to 3+ (30- 300 mg/ dL)
Sp. Gravity	1.000 to 1.015
Urobilinogen	normal to 1+ (≥ 2- 3 mg/ dL)

2.13 Normal range:

1. Glucose- Qualitative tests; negative if normal.
2. Bilirubin- Qualitative tests; negative if normal.
3. Ketone/ Acetone- Qualitative tests; negative if normal.
4. Specific gravity- 1.015 to 1.025 is normal.
5. Blood- Qualitative tests; negative if normal; if positive it is graded from 1+ to 4+.
6. pH- 5- 6.8 is acidic; 7 is neutral; more than 7 is alkaline.
7. Protein- Semi- Qualitative tests; negative if normal; if positive it is graded from 1+ to 4+.
8. Urobilinogen- Qualitative test; negative if normal.

9. Nitrite- Qualitative tests; negative if normal; if positive it is graded from 1+ to 4+.
10. Leukocytes- Qualitative tests; negative if normal; if positive it is graded from 1+ to 4+.

2.14 Alert values:

NA

2.15 Potential source of variation:

"All urine samples for routine urine testing must be processed within 4 hours of sample collection. If exceeding the time limit the sample will be processed and the result will be released with a notification".

2.16 References:

1. Sysmex Fully automated integrated urine analyser UX- 2000 instructions for use.
2. Traceability and measurement of uncertainty UF (II) calibrator for fully automated particle analyser UF- 1000i.